J. E Allen, 1939

THE GEOLOGY AND GROUND WATER OF THE PENDLETON AREA, UMATILLA COUNTY OREGON

Recommendations:

First: Adequate engineering supervision will undoubtedly cut down city and leakage waste and develop the "spring" sources of supply to the capacity (about 5 million gallons per day) of the pipe line. Further development of new "springs" to replace those with polluted water is geologically feasible.

Second: If further emergency or supplementary supply is required after the present system has been brought up to full efficiency, the choice of procedure lies between:

a. Development of North Fork reserves.
b. Installation of a filter plant to utilize river water at Pendleton.
c. Drilling of wells for underground supply.

Third: In case the third of the above alternates is chosen, the Crow Well (NE¼ of Section 21, T. 2 N., R. 33 E.) should be given a pumping test to act as a possible pilot for a well located in the same general favorable position (in sections 2, 10, 11, 14, 15, 16, 21, and 22.).

Introduction:

Location and Extent of Area: The survey embraces an area whose boundaries lie about five miles north and west of the city of Pendleton, and which extends about twenty miles to the east up the drainage system of the Umatilla River, and about ten miles south of the city. The area covered totals about 150 square miles, lying mostly in Ts. 2 N., Rs. 32 to 35 E.W.M., and in parts of T. 1 N., R. 32 and 33 E.W.M. and T. 3 N., R. 36 E.W.M.

Pendleton, the largest city and commercial center of the area, lies near the center of the west portion of the area, and derives its present water supply from the Umatilla area at the east end.

Purpose and Scope of Investigation: The investigation upon which this report is based was made to determine the feasibility of:

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1. Augmenting the flow of the so-called "springs" of the Umatilla to fill the capacity of the supply aquaduct (5 million gallons per day).

2. Developing further possible sources of domestic water in or near the city.

The investigation was requested of the State Department of Geology and Mineral Industries by the Pendleton Water Board, through Rex Ellis, and the expenses of the field work are born by the Water Board.

Field reconnaissance occupied most of the time between November 12 and 22nd, 1939.

Acknowledgements: The writer wishes to acknowledge the generous assistance of Mr. John Vaughn, superintendent of the Water System, Mr. J. M. Adams, engineer in charge of development and repairs, Mr. A. C. Spencer, district watermaster, and the numerous residents of the Pendleton area who have given well and spring data.

Surface Features and Drainage: The area discussed in this report lies on the western edge and partly within the Blue Mountain section of the Columbia River Plateau physiographic province. To the east of Pendleton, the Blue Mountains rise in Cabbage and Emigrant Hills to an elevation of 4000 feet, with a relief of over 2000 feet and youthful V-shaped canyons. To the west, the topography consists of the broad flat plateau divide summits at elevations from 1500 to 2000 feet, incised by relatively steep-walled and in the case of the larger streams flat-bottomed valleys to a depth of from 200 to 1000 feet. The level or gently sloping uplands are parts of the great basalt plain which has been variously called the Ochoco or Shaniko erosion surface. Over a major part of the area this surface approximates the structural surfaces of the underlying lavas.

The Umatilla River flows westward through the center of the area, lying in a 2000 foot canyon with steep walls in the eastern portion of its course. Profiles in this canyon show that its development has had several stages. The river previously reached a stage of maturity or late youth, as shown by the sloping benches remaining on the south side and then cut laterally into these sloping walls to establish cliffs on either side. Most of the erosion seems to have been on the north (right) bank of the stream, where the river flows at present over a majority of its course in this portion of the area. Although there have been flood plains developed from ¼ to ½ mile wide, aggradation has resulted only over intermittent stretches.

Near the town of Cayuse, the Umatilla debouches from the deep canyon, and for a distance of about eight miles lies in a valley up to two miles in width, lying only two hundred feet below the plateau surface. Several wide terraces have been developed within this area.

Approaching Pendleton from the east, the plateau surface rises and the river again flows between steep cliffed walls up to 1000 feet high, although it still maintains a flat bottom from one quarter to one half a mile in width.

The gradient throughout the area is about 29 feet to the mile, being steeper in the eastern portion, and less in the west.

The major tributary creeks (Meacham, Wildhorse, McKay and Birch Cks.) are well adjusted to the Umatilla gradient, and have developed flood plains of their own up to several hundred feet in width. Smaller tributaries sometimes show a distinct break in their profile at their mouths, and in some minor cases (near Homly) have hanging mouths.

Southeast of Pendleton, a great piedmont rises on a slope of about 1° to the base of the Blue Mountain Hills, whose average frontal slope is 6°.

Climate and River Flow: The western portion of the Pendleton area is semiarid, characterized by warm dry summers, but rather cold winters. The eastern portion of the region is cooler in summer and has a higher precipitation during the winter. At Meacham the average winter monthly precipitation is about four inches; in summer it drops to less than one. At Weston the average is only about 2 inches, more nearly that of Pendleton.

There is a direct relation between the precipitation at Meacham and the flow in the Umatilla, which has been calculated from the snowfall and the amount of release of the water. The river flow above Meacham Creek rises in the winter floods to flows from 200 to 600 second feet, but drops to minimums of from 25 to 35 second feet in dry months. During one month there was almost no variation in flow during lowest water, suggesting spring sources above that point.

At Pendleton the maximum floods are much larger, from 1000 to 2000 second feet on an average, and the minimum flow is usually less than that above Meacham Creek for several of the dry months, averaging from 20 to 30 second feet. The evaporation, water system, and irrigation removes more than is brought in by Meacham Creek and the other tributaries. This is suggestive that there are few or no actual springs adding water to the river flow below Meacham Creek.

Stratigraphy:

General Characteristics and Age: The rocks of the Pendleton area include lava flows of Miocene age overlain by gravels of late Tertiary or early Quaternary age, wind deposited sands and silts of Pleistocene age, and river bench bottom gravels of Pleistocene or Recent age.

Columbia River Basalt: These dark grey weathering lavas appear in flows from 10 to 50 feet in thickness, averaging about 20 feet in the outcrops

exposed along the Umatilla. The lower ten feet of the individual flows are characteristically massive, only broken by tight jointing into polygonal columns across the thickness of the flow, from 1 to 4 feet in diameter. The upper ten feet of the average flow is usually vesicular and often red in color, and is capped by a thin layer of red clay representing the oxidized soil cover developed between times of outflow.

Agglomeratic phases not infrequently appear, but in most cases cannot be proven to be wide in extent, and probably lens out in all directions. These consist of highly vesicular fragments and blocks of red lava intermixed with lapilli and cinders, in a matrix of yellow to white sub-opalline clay-like material, probably originating from syngenetic hydration of basaltic glass. One bed of this material outcrops on both sides of the river just E. of Pendleton. Well developed pillow basalt with pillows up to 10 feet in length are exposed in several road cuts, indicating the flow of lava into water. Some of these more porous beds are as much as 50 feet thick, but due to the scarcity of good outcrops their extent cannot be determined.

On McKay Creek south of Table Rock, massive agglomerate outcrops on the north side of the canyon appear to unconformably underly the basalt, and may represent rocks of an earlier (Clarno?) age. If this is so, the thickness of the Columbia River basalt here is not over 3000'.

Older Gravels: Immediately overlying the basalt in a number of places, thick beds of medium-sized (1 to 5 inches) gravels appear at varying elevations. Although these probably represent old river terraces in part, they also occur on the summit of the plateau surface (just west of McKay Dam, in highway cuts west of Pendleton, etc.) and may be late Tertiary in age. South of Pendleton they are over 200 feet in thickness, but usually are much less. They contain interbedded lenticular sand and grit layers, and have undergone some cementation by calcareous deposition. They are not extensive or continuous enough to affect the water situation in any

large degree.

Palouse Formation: The buff-colored fine silts which cover most of the area west of the Blue Mountain front are probably in large part wind-lain, and are correlated with the Palouse formation (Pleistocene) of eastern Washington. It is this fertile deposit which makes the Pendleton area famous for its fertility, and one of the wheat centers of the west. The thicknesses of these deposits are very variable, and they mask much of the structure of the underlying rocks. They have little bearing upon the underground water.

Younger Alluvium: A relatively thin veneer of recent river gravel, sand and silt mantles the flat bottoms of the Umatilla and its larger tributaries, and the lower terraces along the streams. Although they have a depth of 56 feet near Ryan Creek, and of 90 feet still farther up the river (Lacy Pocket) bedrock is said to outcrop across the river at a number of places lower down the stream. At the State Game Farm a well hit bedrock at 32 feet. A well at Pendleton was in bedrock within a few feet.

Traces of previous channels of the river are in evidence from Pendleton up the river beyond Meacham Creek, and form a typical "braided" pattern on the flat valley floor. The water table is seldom deeper than a few feet in these gravels, and outcrops in places along "yazoo" streams (running parallel to the main river on the same valley floor) and in oxbow lakes (cut-off meanders).

These outcrops of the water table in the river gravels form what is known as "springs" and by tapping these water-bearing gravels by means of shallow wells ("manholes") over a distance of 4 miles between Thorn Hollow and Squaw Creek, the city of Pendleton has obtained its domestic water supply.

Structure:

Folding: The main structural feature of the region is a broad north-plunging

syncline or rock basin whose axis crosses the Umatilla River at the Umatilla Indian Agency. The lavas on the west flank of this "Agency Syncline" rise to the northwest for 4 or 5 miles, the dip being 1 to 2½° to the E.S.E. They approach horizontally northwest of Pendleton. On the east flank the lavas dip from 2 to 5° to the northwest, rising to the S.E. in the great eroded monocline or rock fold of Cabbage and Emigrant Hills.

The axis of the syncline extends from Blakely on the north (it could be traced no farther, but evidently basins out against the back slope of the Walla Walla escarpment) through the Indian Agency nearly to Pilot Rock on the south although it plunges as much as 2° to the north on its southern end.

Faulting: Faults striking about N. 20° E. north of McKay Creek and parallel to the front of the Blue Mountains, are suggested both by physiographic evidence and by the abrupt changes in dip of the lavas. It is quite probable that the monoclinal structure of the range front was locally broken by faulting. Two small north-south offsets in the lavas appear along the Umatilla in Section 2, east of Cayuse.

Occurrence and Recovery of Ground Water:

General Features: The underground water of the Pendleton area is of meteoric origin, derived from rain, snow and streams, which has percolated down through the rock to a level below which the permeable rock is saturated with water. This level is known as the water table, and the water in the saturated zone below is called ground water. The water table outcrops at the edges of the rivers and streams and at springs. It may rise or fall, as the permeable rocks fill up or are drained of their water content. The pumping of a well usually causes the water table around it to sink, and if the water in the rocks cannot flow fast enough to replenish the supply, the well can be temporarily pumped dry.

Most rocks are not permeable throughout, but consist of alternating permeable

and impermeable layers. Thus the water may enter the permeable bed or aquafer at its outcrop and fill it; the confined water then being under hydrostatic pressure within that bed so that it may give rise to an artesian flow if the outlet is lower than the inlet.

Water in the Younger Alluvium: The "springs" of the Pendleton water district are wells dug in the highly permeable gravels lying in or near old river channels. These gravels and sands act as natural filters for the water percolating through them from the river itself. In channels which have been recently occupied by the river, it is possible that there is only a small amount of finer sand, so that the filter system is inefficient. If the wells are placed too close to the present river, the amount of filtering material between the well and the river may be insufficient to properly purify the water. If water is allowed to stand in stagnant pools near the wells, algae growing in these pools may pollute the wells.

At the Wenix, Simon, and Longhair "springs" developments the intakes were not put near recent river channels; but at Chaplish the eastern (1938) inlet pipes were placed beneath a recent channel of the river, while the river was diverted further to the north by revetment. This old channel is incompletely drained so that stagnant pools in which algae can grow stand there most of the year.

A well placed upstream from another well and along the same underground channel may deprive the lower well of its water supply. The main Chaplish intake lies in the same channel as the south Chaplish; the Chaplish auxiliary taps in part the same channels as the north Chaplish.

These problems, as well as those of leakage from the mains and restriction of flow due to plant growth are being studied at the present time and plans are being made for their remedy.

Several undeveloped areas of underground channels remain within the three miles

along the river covered by the intake lines. Those of especial promise lie 2000' west of Gibbon just south and east of the town of Thorn Hollow; and just east of the Adams road. A large flow could undoubtedly be developed from the channels one half to one mile west of the Weir House, but these lie below the pipe level, and the water would have to be pumped to the line.

It is extremely doubtful whether any but a very minor amount of the flow of this area is derived from bedrock springs.

Younger gravels in other areas are insufficient in quantity to supply adequate water for city use.

Water in the Palouse Soils and Older Gravels: The older gravels and Palouse soils in most cases lie upon the summits of the plateaus or upon their steeper slopes. They are much dissected by erosion, and except upon the wider plateau summits where there is little water to be collected, are not continuous enough to act as well defined water reservoirs or aquafers.

Water in the Columbia River Basalts: Porous layers of water-bearing potentialities are rather scarce within the Columbia River basalt in the Pendleton area. At the east edge of town a layer of agglomerate over ten feet thick is exposed in highway cuts on both sides of the river. Lava flows in a large number of widely separated localities have upper vesicular portions up to ten feet thick, but although these are porous they are not always permeable. The contacts of flows frequently show cindery or bouldery beds which would act as channels. However, there are no widespread and continuous layers within the basalt which can be definitely pointed to as potential water-carriers.

If water-permeable bed or beds are folded into the structural basin or syncline in the basalt whose lowest point on the Umatilla River lies near the Indian Agency, they would act as natural filters to the water percolating down these beds from the

river, and as reservoirs for any wells which would tap them. The surface level of wells within this area is high, indicating artesian possibilities, but no adequate test has been made in the area.

The Game Farm Well pumps a quarter of a million gallons per day through to June, but runs dry in July and August. Its depth is 210 feet, whereas the extension under it of the porous bed noted east of Pendleton would lie at a depth of nearly 600 feet.

The Crow Well (Wright Ranch) is about 820 feet deep, and has a small flow of artesian water. There is no record that it has ever been tested by pumping. The porous bed noted above would intersect it at a depth of about 900 feet.

Natural springs occur a mile east of Cayuse, flowing from the vesicular upper portion of a lava flow in the south bank of the river just above the road.

There are no deep wells in the area, the 800 foot Crow Well being the deepest.

Conclusions:

1. Geologic conditions are favorable for the augmentation of the flow of the "springs" of the Umatilla between Homley and Sheep Creek by:
   a. Testing flow of various lines, cleaning lines, locating losses in lines. An engineering problem to see what the system can do when working at maximum efficiency.
   b. Developing new "springs" at various indicated places along the river.
2. Geologic conditions are moderately favorable for the development of deep well water near Pendleton, if the need for it should ever occur. The available geologic data suggests as an optimum location for the drilling of such a well, as near the Indian Agency, or south of it near the Crow Well. Before such drilling, the Crow Well itself should be given a pilot test, especially as adequate well data in the area is very scanty.

CHEMICAL COMPOSITION OF LOCAL WATER

Parts per million	Domestic Laundry Well	City Water	Roesch Brewery Wells
Turbidity	No sed.	No sed.	Slight sed.
Residue	205	149	139
Residue upon ignition	145	109	99
Loss upon ignition	60	40	40
SiO_2	16	6	11
CaO	14	17	18
MgO	15.2	10.8	7.2
Chlorine	7.1	6.4	6.4
SO_3	26.1	27.5	27.5
CO_2 (free)		4.6	3.8
Bicarbonate alkalinity	84	46	48
Carbonate alkalinity	8		
Temporary hardness (as $CaCO_3$)	63.1	46.0	48.0
Total hardness (as $CaCO_3$)	63.1	57.4	50.3

SOME WELLS IN THE PENDLETON AREA

mber	#1	#2	#3
cation	NW¼ Sec. 11 T2N., R32E.	E½ of NE¼ Sec. 24, T2N., R33E.	NW¼ Sec. 9 T2N., R33E
mer	Domestic Laundry	Frank Nagel	State Game Farm
te	Nov. 13, 1939	Nov. 20, 1939	Nov. 20, 1939
pog. Situation	River valley bottom	Plateau summit	River valley bottom
ltitude	1075'	1390'	1220'
ype of Well	Drilled	Drilled	Drilled
iameter	8" for 400'; rest 6"	8" for 50'; 6" rest	10"
epth	468'	820'+	210'
epth of Casing	16'	?	82'
epth of Static Level	-32'	+2½'	-9'
Depth to Water Bed	360'		
Name of Driller	Wm. Ruther	John Crow	Wm. Ruther
Date of Drilling	1937	1917?	1934
Method of Lift	Rotary pump	Never pumped?	Byron-Johnson deepwell, 7½ H.P.
Capacity of Pump	3 g.p.m.		350 g.p.m.
Yield	Up to 30 g.p.m. now variable	?	350 g.p.m. except July and August
Drawdown	To 162'		
Remarks	Pump at 170'	On Wm. Wright ranch. Some lime; sulfur in shallow well nearby	Bedrock at 32'

SOME WELLS IN THE PENDLETON AREA (Cont.)

Number	#4	#5	#6
Location	NW¼ Sec. 15	SE Cor. Sec. 3 T1N., R33E.	S½ Sec. 32 T3N., R32E.
Owner	Donald Robinson	Herbert Thomspon	Pendleton Airport
Date	Nov. 20, 1939	Nov. 12, 1939	Nov. 18, 1939
Topog. Situation	Slope to river	Mouth of ck.	Top of Plateau
Altitude	1360'	1825'	1490'
Type of Well	Dug	Drilled	Drilled
Diameter	3'	3"?	
Depth	18'	120'	525'
Depth of Casing		?	
Depth of Static Level	+1	+2'?	
Depth to Water Bed	Spring	102'	300', polluted water
Name of Driller		W.P.A.	Wm. Ruthers
Date of Drilling	1939	1937	
Method of lift		Artesian	
Capacity of Pump			
Yield	500 gals per day	30 g.p.m. at first	
Drawdown			
Remarks		Now flows 3/4" pipe	Went dry after 1935 quake

SOME WELLS IN THE PENDLETON AREA (Cont.)

Number	#7	#8	#9
Location	Center Sec. 27 T3N., R32E.	NE¼ Sec. 33 T3N., R32E.	SE Cor. Sec. 33 T3N., R32E.
Owner	Jacob F. Snyder	David H. Jones	D. H. Nelson
Date			
Topog. Situation	Top of Plateau	Top of Plateau	200' below Plateau
Altitude	1490'	1450'	1300'
Type of well	Drilled	Drilled	Drilled
Diameter			2" casing
Depth	525'	525'	465'
Depth of Casing			
Depth of Static Level			
Depth to Water Bed			
Name of Driller	Fred Ehrel		
Date of Drilling			
Method of Lift			
Capacity of Pump			27 strokes/min.16" stroke 2" case s
Yield			
Drawdown			
Remarks	Has pumped several days without exhausting	Can pump all day	Has pumped 4-5 days steadily

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