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STATE OF WASHINGTON
Department of Conservation and Development
D. A. SCOTT Director

DIVISION OF GEOLOGY
S. SHEDD, Supervisor

BULLETIN No. 26
(Geological Series)

Underground Water Supply

Of the Region About White Bluffs
and Hanford

By OLAF P. JENKINS

OLYMPIA
FRANK M. LAMBORN PUBLIC PRINTER
1922

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LETTER OF TRANSMITTAL

---

*Hon. D. A. Scott; Director, Department of Conservation
and Development, Olympia, Washington:*

SIR: I am transmitting herewith the manuscript of a report on the Underground Water Supply of the Region About White Bluffs and Hanford. This work was done at your request in order to help determine the selection of tracts of land, for soldier settlement, where irrigation is possible.

On account of the somewhat general character of this work and in the hope that it may be of value in helping to solve similar problems in other localities, I suggest that it be published as a Bulletin of the Division of Geology.

Yours respectfully,

S. SHEDD,

Supervisor of Geology.

College Station, Pullman,

April 26, 1922.

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INTRODUCTION

PURPOSE

An investigation of the underground water supply of the region about White Bluffs and Hanford was made in order to ascertain the permanency and sufficiency of this supply for the lands of the district, relative to the Soldier Land Settlement Project. The results of the work are presented in this report and it is hoped that they will be of value in the future development of this region. Besides, the geological principles involved in this study may be applied to many other regions located in similar positions along the ancient flood plains of the Columbia River.

LOCATION

The towns of Hanford and White Bluffs are located on an ancient and extensive alluvial flood plain of the Columbia River on the inside of a sharp bend in this river 30 or 40 miles north in a straight line from Kennewick, in the northern corner of Benton County. Although these towns are generally reached by stage from Kennewick, a branch line of the Chicago, Milwaukee and St. Paul Railroad extends south from Beverly, which is on the main line, to Hanford.

CONCLUSIONS

From this study I have come to the following conclusions:

1. That the principal source of the underground water of this region is the Columbia River.
2. That the alluvial gravels of the district are probably supplied with water principally during the time when the river is at its highest level.
3. That the river probably charges the alluvial gravels with water principally in the region west of White Bluffs and probably above Coyote Rapids.

4. That such a source insures the sufficiency and permanency of the water supply desired by those who wish to secure water for irrigation purposes by means of pumping from wells.

5. That the water table will probably not be lowered materially by local pumping for irrigation.

6. That the migration or seepage of water through the sands and gravels of the district takes place fairly rapidly.

7. That the floor upon which the alluvial gravels rest is probably composed of clay or shale and fine sand similar to that material in the White Bluffs across the river, and in some places basalt, similar to that on Gable Mountain.

8. That the water table is at its highest mark when the irrigation need is greatest, and is at its lowest mark in winter time.

9. That the depth, to water, in a well in this region depends upon the height of the general water table at a given time and upon the elevation of the surface where the well is to be dug.

10. That the Hanford Irrigation Ditch affects only locally the height of the water table by raising it in regions where the ditch leaks.

CONDITIONS

According to the plan of the State Soldier Settlement Project, each tract of land should be 20 acres in size and should be provided with a well for irrigation purposes, with a pump adequate in size to deliver water from the well to meet the demands of the entire tract. These lands under consideration are shown on the accompanying map.

The Consumers' Ditch Company reports that the amount of water they delivered per acre over the entire season of 1920 was 49.72 inches. The amount of water

needed, however, varies with each individual case. It is said that 64 acre inches would be sufficient for any case. The irrigation period is from April 1st to October 31st, but the great demand is during July and August, when the use would equal 96 to 126 acre inches if continued at that rate over the whole season.

For a 20-acre tract, the use of a 4-inch pump has been recommended, designed for 325 gallons per minute, with a total head of 40 feet, and connected directly to a 5 horse-power motor.

These data should give some idea of the supply of underground water necessary to meet the demands of the project.

SOURCE OF DATA

A large amount of working material was supplied the writer by Mr. D. S. Wilkinson of White Bluffs and Mr. Charles M. Sanford of Hanford. This consisted of well data, a detailed topographic map of the most important part of the region not covered by the maps of the U. S. Geological Survey, and statistical information regarding the fluctuation of the river level, and the varying amounts of water used by the Consumers' Ditch Company of that region. In addition to this material a considerable amount of miscellaneous data was secured with the help of these two gentlemen, who also assisted very materially in the measurement of the depth of the wells and the depth of the water level in each of the accessible wells of the region. We visited 180 wells, but 47 of these we were unable to sound. In only one or two cases are the recorded soundings not our own.

The published material concerning the region under discussion consists of the following:

- Kocher and Strahorn: Soil Survey of Benton County, Wash. U. S. Dept. of Agriculture. 1919.
Topographic Maps of the U. S. Geol. Survey: Coyote Rapids Quadrangle and Priest Rapids Quadrangle.

- Merriam and Buwalda: Age of Strata Referred to the Ellensburg Formation in the White Bluffs of the Columbia River. Univ. of Calif. Publ., Bull. of the Dept. of Geol., Vol. 10, No. 15, pp. 255-266. 1917.
- Campbell, M. R.: Guidebook of the Western United States. Part A, The Northern Pacific Route. U. S. Geol. Survey, Bull. 611. 1915.
- Waring, Gerald A.: Geology and Water Resources of a Portion of South-Central Washington. U. S. Geol. Sur., Water-Supply Paper No. 316. 1913.
- Calkins, Frank C.: Geology and Water Resources of a Portion of East-Central Washington. U. S. Geol. Sur., Water-Supply and Irr. Paper No. 118. 1905.
- Russell, I. C.: A Geological Reconnoissance in Central Washington. U. S. Geol. Sur., Bull. 108. 1893.

EXPLANATION OF THE MAP

The map which is included in this report has been compiled from several sources of information. The more detailed portion, the eastern half, was taken from a map prepared by the Hanford Irrigation Project, originally drawn for the purpose of showing soil classification. The rest of the map was compiled from topographic sheets of the United States Geological Survey (Coyote Rapids and Priest Rapids quadrangles) and the Soil Survey of Benton County, issued by the United States Department of Agriculture. Other maps from which data were obtained were supplied also from the information gathered by the Hanford Irrigation and Power Co. The location of the wells was made by Mr. Charles M. Sanford, while the depths of the wells were sounded by Mr. Sanford and Mr. D. S. Wilkinson, working together with the writer. The elevation of the surface of each well was obtained through rough computation from the position of the well relative to the contours drawn on the original maps. The numbers of the wells have been taken arbitrarily for reference. All data concerning the elevation or depth of the water level in the wells, on the surface of the river, and on the surface of the seepages, were taken during the same interval of

time, namely, between October 19th and October 26th, so that a fair comparison is thus made in the interpretation of the position of the water table in reference to river elevation.

There is an inconsistency in the map in relation to contour intervals, owing to a different source of compiled data. In the western portion of this map 25-foot contours are recorded, whereas to the east, 10-foot contours have been drawn. It is thought that this information, though it does not tie properly across the map, is of value in the consideration of the problem as a whole.

The locations on the map of the settlement lands under consideration were obtained during the time the field work was done, and it is probable they may be changed after further consideration of the project.

Geological features, secured through field work, are also represented on the map. The formations are delineated by contact lines which are drawn on the map. The principal formations are: (1) the basalt which makes up the non-irrigable high hills of the district; (2) the lake bed formation which is exposed outside of the particular area under consideration, but which probably underlies the gravels of the district; (3) the old river flood plain of sand and gravel material, upon which the lands under consideration are located and in which the wells are dug; and (4) the present river bed which is covered completely at high water level.

The lines showing the axes of an anticline and a syncline in the basalt are of interest only in connection with the general structure of the basalt and the position of the artesian wells thus related. The anticline is a great arch in the basalt layer. The syncline is a structural trough (not necessarily topographical) also in the basalt.

GEOLOGICAL FEATURES

DESCRIPTION OF THE GEOLOGICAL FORMATIONS

A long ridge of basalt, running in an east and west direction, extends from the south side of the river at Priest Rapids towards Hanford. It is covered in its very lowest parts, or saddles, by this old flood plain of alluvium so that prominent peaks such as Gable Butte and the sharp ridge known as Gable Mountain stand out as great islands in this extensive desert-like area. The basalt layers which make up these ridges have been tilted from their original horizontal positions to various angles and now, in some places, stand nearly on end. The basalt rocks comprise the oldest formation exposed in the region.

On the eastern side of the river are high bluffs of an evenly stratified sedimentary formation composed of clays, fine silts, and sand. The uppermost layers, those which comprise most of the bluff, are lying in a flat or horizontal position. Beneath them, exposed in a more limited area, are sedimentary beds somewhat similar to the horizontal layers in content, but which are tilted steeply and are overlain unconformably by the later flat-lying bedded formation. All these sediments represent deposition in lakes. The lower beds represent an older lake deposit whose age is probably the same as that of the basalt, having been thrown into folds similar to those of the basalt. The upper horizontally lying lake beds, whose white escarpment has suggested the name "White Bluffs", are much younger in age but are older than the gravels of the great river plain. In places near the foot of the bluffs, exposures give proof that these river gravels overlie the lake bed formation, thus proving the relative age of the formations.

The great deltaic alluvial plain extends from the river on the east to the foot of the Rattlesnake Hills on the

west, along the line from China Bar at the north to a sharp bend in the Yakima River at the south, toward Richland. During the close of the glacial period the Columbia River must have carried a vast amount of water, together with an immense load of sand and gravel. It appears that the river entered this region after passing through a narrow gorge (Saddle Mountain and Priest Rapids), and discharged or spread out over this wider district which had been formerly an old lake bed. The river, thus slackened in its speed at this position, deposited a large part of its tremendous load of gravel and sand. The various courses which the river took are evident over this area in the form of long channels, or depressed areas in the alluvium, running from west to east. One old channel of the Columbia River appears to have been on the western edge of this territory and evidently took the course which the Yakima River now takes from a point in its sharp bend at The Horn to the place where it now enters the present Columbia River. Another old conspicuous channel occurs on the south and east side of Gable Mountain. In its lowest point there is a spring which is said to flow during the time of the year when the river is higher than it was when this investigation was made. The elevation of the position of this spring is 400 feet, which is a little higher than the water table was found to be at that time, and that fact probably accounts for the spring not issuing when the river is low.

The present river gravel bars, over which the river flows at its highest point, represent the youngest portion of the more extensive and older flood plain. All these gravels and sands are very coarse, and the interstices between the boulders are large. Thus the ground water may pass through this material readily.

Although this underground water does not travel in open channels, there may be, however, certain areas in which coarser material occurs and through which the

DIVISION OF GEOLOGY

BULLETIN No. 26. PLATE II.

a. The Columbia River at China Bar, showing the kind of gravel into which much of the water of the river soaks.

b. Discharge of ground water into an arm of the river. One of the springs in Sec. 23, T. 13, R. 27 E.

water would thus pass more rapidly. It is quite possible, therefore, for the ground water to be more abundant in certain places than in others.

GEOLOGICAL HISTORY

The extensive lake deposits of silt, clay and fine sand, represented in the north bluffs of the river, were probably formed before the glacial period. The older of the two lake bed formations, exposed in this escarpment, is known as the *Ellensburg formation* of Miocene age, while the younger flat-lying beds comprise the *Ringold formation* of late Pliocene or early Pleistocene age. The younger of the two lakes was formed probably by the damming of the former Columbia River by earth disturbances which caused east-west folds in the basalt series to be thrown across this drainage system. These folds are clearly exposed, such as that along the continuation of the ridge of which Gable Mountain forms a segment, and the ridge known as the Rattlesnake Hills. The lake was undoubtedly drained and a new river course established, cutting through these sediments, before the great ice sheet to the north was formed. This ice sheet later caused the Columbia River to take a different course by way of the Grand Coulee and the channel now known as Crab Creek. After the ice melted, the Columbia River resumed its former position, approximately, and evidently was filled with a tremendous amount of water and sediment which caused the action in the formation of the deltaic flood plain.

The gravel of the alluvial plain therefore overlies not only the basalt, as that which forms Gable Mountain, but it overlies the lake bed deposits. The floor of the gravel is thus a quite impervious material, composed largely of clay. This also serves as the floor of the ground water of this region.

THE WATER TABLE

TABULATION OF WELL DATA

Explanation and reliability of the data. The numbers in the first column of the list which follows have been arbitrarily taken for reference to the wells. In the second column, the names refer to the owners of the wells or to the name of the property on which the well is located. The next three columns are grouped together as "well location" and are given together as an index to the finding of the well in reference to the map (section, township, and range). The next two columns are devoted to the depth to the bottom of the well and the depth to the surface of the water in the well. Wherever both these figures are given this information was obtained by lowering a sounding line in the well itself and measuring the distance from the surface to the bottom and from the surface to the level of the water. These data were collected in the field during October 19 to October 26, 1921. Where the depth to water is not given the well was not sounded, excepting in one or two cases where authentic information was obtained.

In the next three columns are given the elevation in feet above sea level. In the first of these the elevation of the surface of the ground at the location of the well has been computed from topographic maps. The figures in the second column of this series have been obtained by subtracting the depth to water level in the well from the elevation of the surface of the ground. The third column of this series refers to the elevation of the level of the river at a point nearest the location of the well. It has been computed from two elevations—one at Coyote Rapids and the other at Hanford Sub-station—taking into account the general gradual fall of the river from the upper point to the lower. Thus, the elevation of the

water table given in the second column of this series can be compared to the elevation of the nearest point in the river.

The next column, marked "Do. or Irr.," refers to the words *domestic* or *irrigation*. In the first case it is meant that the well is used for domestic purposes, and in the second for irrigation. In the column entitled "Well Size" the figures refer to feet, excepting those which are indicated ("). Following this column is one marked "G's. Per Min.," which means *gallons per minute* and refers to the amount of water which is generally pumped during the summer months from the well. The last column, entitled "Aers.," shows the number of acres watered by the irrigation wells.

The blank spaces which are left in this table have been left blank because no accurate data were procured.

The most important feature of this table is that this information concerning the water within the wells has been obtained during a given time, and any further information which may later be obtained concerning the water level cannot be included in this list without changing its meaning. That is to say, the water table, or elevation of the water level within the wells, fluctuates from time to time so that an elevation of the water level in one well must be compared to that in another well during the same interval of time. Also, the elevation of the river must be compared to the elevation of the water table during the same interval.

TABULATED DATA OF WELLS ABOUT WHITE BLUFFS AND HANFORD

No.	NAME	Well Location			Depth to		Approximate Elevation of			Do. or Irr.	Well Size	G'ls. per Min.	Acres.
		Sec.	T.	R.	Bot.	Wtr.	Sur.	Wtr.	River				
1	H. F. Paschen.....	SE 15	13	27	22½	16	385	369	357	I	7x7	.....	.....
2	A. Wheeler.....	NE 15	13	27	.....	.....	389	.....	358	D	12"	.....	.....
3	B. Riegler.....	SW 15	13	27	30	20½	393	372	357	I	24"	250	29
4	B. Salvini.....	SE 15	13	27	28½	20	390	370	357	D	4x4	.....	.....
5	F. E. Ollenman.....	SW 15	13	27	24	25½	385	360	357	D	4x4	.....	.....
6	O. W. Johnston.....	NE 15	13	27	22	16½	390	374	357	I	6x6	.....	.....
7	C. Snyder.....	NW 15	13	27	22	17	392	375	358	D	4x4	.....	.....
8	L. T. Brooks.....	NW 15	13	27	21	16½	390	374	358	D	4x4	.....	.....
9	School.....	NE 16	13	27	22	.....	392	.....	358	D	18"	.....	.....
10	J. Witte.....	NE 16	13	27	50	.....	391	.....	358	I	.....	.....	.....
11	J. Witte.....	NE 16	13	27	26	.....	380	.....	358	I	4x4	.....	.....
12	H. Brown.....	SE 9	13	27	22	20	390	370	359	D	4x4	.....	.....
13	Jay Smith.....	SW 15	13	27	44	37	408	371	357	I	6x6	200	10
14	D. C. Buckholdt.....	SW 15	13	27	50	41	410	369	357	I	6x6	360	20
15	E. Grant.....	NW 22	13	27	48	40	410	370	357	I	4x5	100	10
16	F. B. Hicks.....	NW 22	13	27	49½	41	411	370	357	D	12"	.....	.....
17	T. H. Heath.....	SE 22	13	27	44½	36	401	365	356	D	12"	.....	.....
18	C. Beeg.....	SE 22	13	27	48	.....	400	.....	355	D	3½x3½	.....	.....
19	C. Hart.....	SE 22	13	27	45	.....	401	.....	356	D	3x4	.....	.....
20	Rob. Nichols.....	SE 22	13	27	42½	35½	405	370	356	I	6x6	.....	.....
21	W. R. Adamson.....	SW 23	13	27	43½	36	405	369	356	I	4½x5½	175	.....
22	J. F. Conkle.....	SW 23	13	27	46	38	406	368	356	I	5x5	250	.....
23	R. W. McDonnell.....	SW 23	13	27	48	41½	410	369	355	I	4x5	250	.....
24	R. W. McDonnell.....	SW 23	13	27	42	37½	407	370	355	D	4x5	.....	.....
25	H. E. Purlington.....	SE 23	13	27	36½	31	400	369	355	D	12"	.....	.....
26	G. E. Burford.....	NE 23	13	27	31	24	395?	371?	356	I	6x6	185	.....
27	L. H. Clark.....	SE 23	13	27	50	43	410	367	355	I	6x6	215	11
28	C. Daregio.....	SE 21	13	27	53	.....	412	.....	356	D	3x4	.....	.....
29	W. H. Welmeier.....	NE 26	13	27	43	35½	401	366	354	D	12"	.....	.....
30	J. M. Clark.....	NE 26	13	27	53½	43	412	369	355	D	8"	.....	.....
31	J. E. Evett.....	NW 26	13	27	42½	35	400	365	355	D	4x4	.....	.....
32	A. G. Evett.....	NE 26	13	27	48	.....	411	.....	355	D	12"	.....	.....
33	N. P. Anglin.....	NE 26	13	27	66	.....	409	.....	355	D	4x4	.....	.....
34	A. Simpson.....	NE 23	13	27	40	.....	410	.....	355	D	3x4	.....	.....
35	G. McConnachie.....	SE 26	13	27	45	.....	401	.....	354	D	12"	.....	.....
36	A. McConnachie.....	SE 26	13	27	38½	32	400	368	354	D	4x4	.....	.....
37	J. Macomber.....	SW 25	13	27	36	29	399	370	354	D	12"	.....	.....
38	C. L. McGlaughlin.....	SW 25	13	27	32½	26	395	369	354	D	3x4	.....	.....
39	M. W. Gross.....	NE 36	13	27	49	.....	396	.....	353	D	.....	.....	.....
40	M. W. Gross.....	NE 36	13	27	41	35	403	368	353	I	4x4	420	.....
41	J. C. Syford.....	NW 36	13	27	44	.....	409	.....	353	D	8"	.....	.....
42	G. T. Slavins.....	NE 36	13	27	50	44	415	371	353	D	4x4	.....	.....
43	John Blackler.....	SW 25	13	27	41½	34	413	379	353	D	14"	.....	.....
44	C. Rolph.....	NW 31	13	28	22	25	389	364	352	D	4x4	.....	.....
45	W. H. Rolph.....	NW 31	13	28	33	26½	391	365	353	D	4x4	.....	.....
46	C. W. Sloan.....	NW 31	13	28	32	.....	394	.....	352	D	4x4	.....	.....
47	B. C. Root.....	NW 31	13	28	37	34	396	362	352	D	4x4	.....	.....
48	C. G. Root.....	NW 31	13	28	40	35	398	363	352	D	12"	.....	.....
49	John Loson.....	NW 31	13	28	46	.....	405	.....	352	D	12"	.....	.....
50	W. S. Webber.....	SW 31	13	28	46	.....	396	.....	352	D	8"	.....	.....
51	C. E. Briggs.....	SW 31	13	28	45	.....	400	.....	352	D	.....	.....	.....
52	W. F. Morrison.....	SW 31	13	28	50	47	410	363	352	D	16"	.....	.....
53	Mark Whelan.....	NE 6	12	28	64	60½	420?	360?	351	I	5x5	.....	.....
54	Mark Whelan.....	NE 6	12	28	56	50	402	352	351	D	.....	.....	.....
55	A. Stephenson.....	SW 32	13	28	34½	30	380	350	350	I	3½x3½	.....	.....
56	H. K. Boie.....	SE 26	13	27	44	.....	403	.....	354	D	12"	.....	.....
57	A. H. Zane.....	NE 20	13	27	47	36?	410	374	357	I	.....	325	.....
58	C. Daregio.....	NE 18	13	27	57	.....	363	.....	358	D	.....	.....	.....
59	A. W. Ely.....	NE 20	13	27	51	46	440	394	357	I	6x6	400	.....
60	J. H. DeVeurve.....	SE 17	12	27	73	62	432	370	358	I	8x8	1100	.....
61	J. H. DeVeurve.....	SE 17	12	27	.....	.....	410	.....	357	D	.....	.....	.....
62	F. Wenner.....	NE 22	13	26	20	.....	400	.....	384	D	5x5	.....	.....
63	A. Grell.....	SW 9	13	27	41	15	391	376	359	D	30"	.....	.....
64	Wm. Kerr.....	SW 9	13	27	19	16½	392	376	359	D	3x4	.....	.....
65	L. C. Krug.....	SW 9	13	27	20½	16	390	374	359	D	3x4	.....	.....

Underground Water Supply

19

TABULATED DATA OF WELLS ABOUT WHITE BLUFFS AND HANFORD
— Continued.

No.	NAME	Well Location			Depth to		Approximate Elevation of			Do. or Irr.	Well Size	G'ls. per Min.	Acres.
		Sec.	T.	R.	Bot.	Wtr.	Sur.	Wtr.	River				
66	D. J. Burch.....	NE 7	13	27	25	14	420	406	361	D	3x3	.....	.....
67	K. E. Grant.....	NE 8	13	27	31	24	410	386	360	I	32"	200	.....
68	J. Jourdan.....	SE 5	13	27	23	14	403	389	361	I	3x4	.....	.....
69	J. F. Bleakley.....	NE 5	13	27	34	.....	402	.....	362	D	10"	.....	.....
70	E. C. Coleman.....	NE 5	13	27	18	9	400	391	363	D	4x4	.....	.....
71	M. Taylor.....	NW 5	13	27	30	17	410	393	363	D	10"	.....	.....
72	N. D. Showalter.....	NE 8	13	27	16	9	398	389	361	D	4x4	.....	.....
73	E. Anderson.....	NW 6	13	27	34	.....	434	.....	394	I	6x6	.....	.....
74	Hanford Ranch.....	NE 1	13	26	44	36	440	404	364	I	6x6	750	40
75	Hanford Ranch.....	NE 1	13	26	36	26	430	404	364	I	6x6	450	.....
76	C. Rackliff.....	SE 32	14	27	31½	12½	398	386	363	I	3"	250	38
77	C. Rackliff.....	SE 32	14	27	28	5	386	391	362	I	4"	250	.....
78	Wm. McKay.....	SE 32	14	27	22	19	400?	381	363	D	4x4	.....	.....
79	J. P. Weber.....	NE 32	14	27	12	6½	397?	391	363	I	5x5	.....	.....
80	Thos. Williams.....	NE 32	14	27	25	.....	395	.....	364	D	.....	.....	.....
81	J. A. Johnson.....	NE 32	14	27	20	.....	394	.....	364	D	.....	.....	.....
82	Chas. Whitney.....	NW 32	14	27	22	10	399	389	364	I	4 rd.	.....	.....
83	J. McMurry.....	SW 29	14	27	38	24	412	388	364	I	4½x5½	.....	.....
84	R. W. Gruenhagen.....	SW 29	14	27	28	22½	410	382	364	D	4x4	.....	.....
85	C. C. Richard.....	SW 29	14	27	32	.....	400	.....	364	D	3x3	.....	.....
86	Chas. Whitney.....	SW 29	14	27	29	17½	400	383	364	I	2x3	260	.....
87	I. Hawley.....	NE 29	14	27	30	27	405	378	365	D	3x4	.....	.....
88	R. D. Barge.....	NW 29	14	27	28	17	404	387	365	I	2½x3	150	.....
89	J. B. Tromanhauser.....	NW 29	14	27	37	31	410	379	365	I	5x6	.....	.....
90	J. B. Tromanhauser.....	NW 29	14	27	30	24	410	386	365	D	5x5	.....	.....
91	C. Eilertson.....	NW 29	14	27	30½	26	410	384	365	D	4x4	.....	.....
92	M. F. O'Brien.....	NW 29	14	27	30½	31½	410	379	365	D	.....	.....	.....
93	G. W. Shaw.....	NW 29	14	27	40	35	410	375	365	D	4x4	.....	.....
94	J. Tromanhauser.....	SW 20	14	27	42	26	410	374	366	I	6x6	.....	.....
95	J. Tromanhauser.....	SW 20	14	27	50	37½	410	373	366	I	4x4	.....	.....
96	Brice.....	SW 20	14	27	20	.....	.....	.....	366	D	6x6	.....	.....
97	J. McFee.....	SW 20	14	27	16	.....	.....	.....	366	D	Pipe	.....	.....
98	M. E. Houk.....	SW 20	14	27	40	.....	410	.....	366	D	4x4	.....	.....
99	C. C. Coleman.....	NW 19	14	27	36	33	421	388	367	D	3½x3½	.....	.....
100	F. D. Edwards.....	NE 19	14	27	35	.....	410	.....	367	D	3x3	.....	.....
101	S. M. Briscoe.....	SW 19	14	27	32	.....	415	.....	367	D	2"	.....	.....
102	C. Salvini.....	SW 19	14	27	27	22	415	393	367	D	4x4	.....	.....
103	Wm. Gregory.....	SW 19	14	27	26	21	420	399	367	D	18"	.....	.....
104	L. L. Lewis.....	SE 19	14	27	.....	.....	409	.....	367	D	.....	.....	.....
105	A. E. Hunt.....	SE 19	14	27	32	25½	410	385	366	D	6x6	.....	.....
106	J. W. Mowell.....	SW 19	14	27	32	2½	410	382	366	D	6x6	.....	.....
107	Town Well No. 1.....	NE 31	14	27	27	16	410	394	364	I	10x10	.....	.....
108	Town Well No. 2.....	NE 31	14	27	20	19	415	396	364	D	4x4	.....	.....
109	W. P. Inv. Co.....	NE 31	14	27	25	20	410	390	364	I	4x4	.....	.....
110	A. E. Horman.....	SE 36	14	26	52	.....	432	.....	364	I	4x4	.....	.....
111	A. E. Horman.....	SE 36	14	26	36½	33	432	399	364	D	.....	.....	.....
112	Robt. Nitzsche.....	NW 36	14	26	17	14	415	401	365	D	3x4	.....	.....
113	Van Vleet.....	NE 36	14	26	20	.....	416	.....	365	I	.....	.....	.....
114	J. E. Tedford.....	NE 36	14	26	.....	.....	415	.....	365	I	.....	.....	.....
116	Joseph Kiser.....	NE 25	14	26	27	21	417	396	366	I	4x6	.....	.....
117	S. V. Fanning.....	SW 24	14	26	33½	21½	415	394	367	I	8x8	1000	50
118	C. M. Johnson.....	NE 24	14	26	44	33	420	387	368	I	6x6	.....	.....
119	A. F. Peck.....	NE 25	14	26	35	30	419	389	366	I	6x6	.....	15
120	R. R. Woods.....	SW 32	14	27	35	20	409	389	363	I	5x5	.....	22
121	M. S. Brannick.....	SE 13	14	26	42	34	426	392	368	I	6x6	250	25
122	F. J. Bonn.....	SW 9	13	27	9	4	389	385	359	I	6x6	.....	15
123	L. W. Belden.....	SE 18	14	27	44	37	.....	.....	367	I	4x6	200	.....
124	L. E. Bishop.....	SE 18	14	27	36	.....	.....	.....	367	I	8x8	.....	15
125	H. E. Robinson.....	SE 18	14	27	46	.....	.....	.....	368	D	8"	.....	.....
126	E. N. Loveland.....	NE 18	14	27	42	39½	.....	.....	368	D	6"	.....	.....
127	R. M. Williams.....	NE 18	14	27	50	40½	.....	.....	368	D	4x4	.....	.....
128	E. Wade.....	NE 18	14	27	42	.....	405?	.....	368	D	6"	.....	.....
129	R. H. Van Akin.....	SW 18	14	27	23	17	410	393	368	I	6x6	.....	.....
130	Fitzgibbon.....	SW 18	14	27	44	38	423	385	368	I	6x6	.....	.....
131	F. I. Badger.....	SW 18	14	27	26	18½	410	392	368	I	18"	250	16

TABULATED DATA OF WELLS ABOUT WHITE BLUFFS AND HANFORD
—Concluded.

No.	NAME	Well Location			Depth to		Approximate Elevation of			Do. or Irr.	Well Size	G'ls. per Min.	Feet.
		Sec.	T.	R.	Bot.	Wtr.	Sur.	Wtr.	River				
132	L. A. Coddling.....	SW 18	14	27	40	29	408	379	368	I	6x6	100	10
133	G. N. Angle.....	SW 18	14	27	34	28	409	381	368	I	3x3	300	25
134	R. W. Judd.....	NE 18	14	27	42	31	407?	376?	368	I	4x6	225	25
135	F. M. Weil.....	SW 7	14	27	40	.....	405?	.....	370	D	4x4	.....	.....
136	U. S. Agnew.....	SW 7	14	27	39	34	405?	371?	270	D	4x4	.....	.....
137	C. Damyer.....	SW 7	14	27	40 $\frac{1}{2}$	40	405?	365?	370	D	3 $\frac{1}{2}$ x3 $\frac{1}{2}$	.....	.....
138	M. S. Meeks.....	SE 12	14	26	40	37	405?	368?	370	D	3x3	.....	.....
139	Hall Bros.....	SW 12	14	26	29	22	405?	383?	371	I	6x6	250	.....
140	Grenfield.....	SW 12	14	26	26 $\frac{1}{2}$	27	405?	378?	371	I	6x6	.....	.....
141	E. Cords.....	NE 14	14	26	27 $\frac{1}{2}$	18 $\frac{1}{2}$	410?	392?	378	I	8x8	240	21
142	Wm. Mosde.....	NE 14	14	26	32	20	410?	390?	373	I	6x6	.....	.....
143	I. Wright.....	NW 14	14	26	38	.....	440	.....	377	D	7"	.....	.....
144	Wm. Coulson.....	NW 14	14	26	26	22	440?	418?	377	I	4x5	.....	.....
145	R. J. Roberts.....	NE 14	14	26	51	41	435	394	373	D	6x6	.....	.....
146	S. Allard.....	NE 6	13	28	58	.....	440?	.....	384	D	4"	.....	.....
147	L. J. Miller.....	SW 6	13	26	60	.....	452?	.....	385	D	4"	.....	.....
148	Miller Ranch.....	NE 12	13	25	92	.....	473?	.....	388	D	4"	.....	.....
149	L. N. Fry.....	NW 12	13	25	72	.....	462?	.....	387	I	5x6	200	20
150	E. F. Remlinger.....	NE 11	13	25	55	51 $\frac{1}{2}$	445?	394?	388	D	4x4	.....	.....
151	Austin Bros.....	NW 4	13	25	41 $\frac{1}{2}$	37	420?	383?	394	I	4x6	1400	100
152	Austin Bros.....	NW 4	13	25	35	33	420?	387?	394	I	4x5	800	45
153	I. Von Herberg.....	SE 5	13	25	68	59	430?	371?	395	D	4x5	.....	.....
154	O. H. Jeager.....	NE 12	13	24	37	+	428?	.....	398	I	3x9	240	.....
155	J. P. Richmond.....	NE 11	13	24	34	22	425?	393?	402	I	12"	240	.....
156	A. R. Knaub.....	NE 14	13	24	62 $\frac{1}{2}$	59	460?	401?	402	I	4x4	.....	.....
157	A. Knoll.....	SW 10	13	24	44	40	423?	383?	404	I	4x4	300	.....
158	A. Brown.....	SW 26	13	24	668	+	1020?	.....	404	I	5 $\frac{1}{2}$ "	1000	.....
159	F. M. Hill.....	NE 25	14	26	26	19	415	396	366	I	6x6	.....	.....
160	M. R. Slavons.....	NW 36	13	27	41	25	405	370	353	D	3"	.....	.....
161	Whaley & Gregg.....	SE 10	13	27	34	30 $\frac{1}{2}$	385	355	358	D	4x4	.....	.....
162	M. B. Haynes.....	SE 23	13	27	41	32	398	366	355	D	4x6	.....	.....
163	W. H. Keal.....	SE 19	14	27	.....	36	411	375	366	D	4x4	.....	.....
164	Mikel.....	SW 25	14	26	21 $\frac{1}{2}$	11 $\frac{1}{2}$	418	407	365	I	8x8	.....	.....
165	Wilson.....	SW 25	14	26	22	14	419	405	365	I	8x8	.....	.....
166	J. E. Coleman.....	SE 19	14	27	36	25	410	385	366	D	6"	.....	.....
167	H. C. Henry.....	NW 5	13	27	38	20	411	391	383	I	6x6	.....	.....
168	Ed. Wagner.....	NE 4	13	25	42 $\frac{1}{2}$	29	418?	389?	394	I	.....	.....	.....
169	R. D. Sapp.....	NW 18	13	26	146	141	537?	396?	384	I	.....	.....	.....
170	Moore.....	SW 12	13	25	67	94	400?	366?	386	I	.....	.....	.....
171	Robertson.....	SW 12	13	25	94 $\frac{1}{2}$	92	488?	396?	383	I	.....	.....	.....
172	Thos. Brown.....	NE 29	14	27	41	34	408	374	365	D	.....	.....	.....
173	H. Ellertson.....	SW 2	14	27	14	13	409	396	365	D	.....	.....	.....
174	F. N. Hensley.....	SE 9	13	27	.....	.....	390	.....	357	I	50"	.....	.....
175	S. Garce.....	NW 23	13	27	21	17	390?	373?	356	I	.....	.....	.....
176	C. Deragio.....	NW 25	13	27	45	33	415	382	354	D	30"	.....	.....
177	C. N. Larson.....	NW 31	13	28	45 $\frac{1}{2}$	38 $\frac{1}{2}$	393	355	352	D	.....	.....	.....
178	Deragio.....	NE 18	13	27	30	25	440	415	361	D	.....	.....	.....
179	Van Akin.....	SW 18	14	27	24	12	410	398	368	I	.....	.....	.....
180	Hill.....	NE 25	14	26	24	20	415	395	366	I	.....	.....	.....

+ No Water. † Artesian.

Remarks. It was found that in general these wells penetrated first a sandy or gravelly soil, then entered loose sand and gravel, without encountering any other material. In some cases a little clay was struck, but not often.

In every case where information was obtained it was reported that the water in the well rose and fell with the rise and fall of the Columbia River. Although the data regarding this feature are not very accurate, they are presented here for what they are worth.

No. Well	Maximum Fluctuation	No. Well	Maximum Fluctuation
14	10 feet	35	9 feet
22	5 feet	41	10 feet
23	4 feet	56	16 feet
25	6 feet	60	6 feet

It is quite probable that the fluctuation is very nearly 10 feet in most cases.

At least 79 of the 180 wells of the district have been used for irrigation. In pumping from these wells by power it seems that the water was lowered a foot or so and then it reached a constant level, remaining there as long as the pumping was continued. These data, also, are only fragmental and approximate at the best.

No. Well	Lowering Caused by Pumping	H. P.	Size Pump (inches)
13	.....	5	3
14	4 inches	7½	4
15	.....	3	2½
21	.....	10	.....
22	few inches	10	3
23	.....	10	.....
26	15 inches	3	3
27	1 inch	5	.....
40	4 to 10 inches	.....	.....
60	about 2 feet	40	6
70	.....	5	4
74	.....	15	5
75	.....	10	.....
76	.....	5	3
82	.....	7½	6
88	.....	3	.....
116	.....	3	3
117	.....	10	6
129	.....	5	3
139	.....	5	.....
140	.....	3	3
142	.....	3	3
151	.....	20	8
155	.....	5	.....
159	.....	3	.....

Example of replenishment. In the case of No. 60, I studied the action which took place in the well itself. A pump which drew from the well 1,100 gallons per minute lowered the water level nearly two feet, and then the water level remained constant. From the sides of the well the ground water was pouring in, replenishing it steadily. This is a good example of the way in which these wells are fed by the underground water supply.

LOG OF WELL DRILLED AT RINGOLD

Location. Ten miles southeast of Hanford, on north bank of Columbia River, near cross-roads by school-house, Sec. 25, T. 12 N., R. 28 E.

Elevation. Drill hole, 430 feet above sea level. River, about 340 (Oct. 24, 1921).

Purpose of Drilling. To obtain artesian water.

Driller. N. C. Jannsen Drilling Company, 414 Northwest Bank Building, Portland, Oregon.

MATERIAL	Thickness in Feet	To
Sand	18	18
Cement gravel	67	85
Clay	20	105
Clay and gravel.....	22	127
Gravel	28	155
Boulders and gravel.....	6	161
Black clay	8	169
Blue clay	9	178
Black clay	18	196
Sand	9	205
Black rock	19	234
Black rock and shale.....	6	240
Shale	17	257
Black rock	151	408
Basalt	63	471
Clay and gravel.....	16	487
Shale	9	496
Rock	39	535
Basalt	2	537
Rock	2	539
Shale	10	549
Black shale	3	552
Blue shale	12	564
Basalt	103	667
Porous basalt	10	677
Basalt	15	692
Blue shale	19	711
Gray sandstone	9	720
Basalt	35	755

It is reported that water stands within 19 feet of the surface.

Remarks. Although this well is some ten miles from Hanford, it represents to a certain extent the materials which would be encountered if deep wells were sunk in the region of Hanford and White Bluffs. That is to say, sand and gravel of the old river flood plain are found to the depth of about 160 feet. Clay and sand, which represent the old underlying lake silt represented in the White Bluffs on the eastern side of the Columbia River, are encountered beneath these sands and gravels for a further depth of at least 40 feet. Beneath this is encountered basalt and a few thin lenses of interbedded local lake deposits.

LOG OF FIRST ARTESIAN WELL NEAR COLD CREEK

Location. 16 miles southwest of White Bluffs, near corner of road, NW $\frac{1}{4}$ -SW $\frac{1}{4}$ Sec. 26, T. 13 N., R. 24 E. Archie Brown, owner.

Elevation. Drill hole, 1,025 feet above sea level.

Purpose of Drilling. To obtain artesian water.

Driller. N. C. Janssen Drilling Company, 414 Northwest Bank Building, Portland, Oregon. October, 1918.

MATERIAL	Thickness in Feet	To
Soil	8	8
Gravel and boulders.....	172	180
Hard basalt	292	427
Water cavity (6 inches).....		
Material (?)	6	478
Sandstone	14	492
Blue shale	75	567
Sand	6	573
Blue shale	10	583
Brown shale	9	592
Green shale	6	598
Honeycomb and water-bearing rock.....	70	668

Artesian water struck at depth of 668 feet. Flow of approximately 2,000 gallons of water per minute, 40 pounds pressure. This well is being used to irrigate a field of alfalfa.

Remarks. This well is located in a syncline which plunges to the east. The well enters basalt at the depth of 180 feet and passes through shale and sandstone which represent an intercalated lake deposit, for basalt is again encountered at the depth of 598 feet. The artesian water issues from "honeycomb," or cellular basalt, and from the coarser material of this interbedded lake deposit.

To the north of this location are extensive exposures of basalt layers, which have been thrown into a great fold or anticline. The basalt layers dip almost vertically into the Columbia River and are folded over so that the southern dips are more gentle. Several miles to the south of Cold Creek is another east-west anticline or fold. Thus the well is located in a syncline or structural trough which lies between the anticlines. The anticlines and the syncline plunge as a whole to the east.

Surface waters have probably entered the basalt to the west, especially the cellular portion and the interbedded sands of a lake deposit, and have passed downward toward the east in this trough or syncline and have

DIVISION OF GEOLOGY

BULLETIN NO. 26. PLATE III.

a. An exposure of sand and gravel near Coyote Rapids. This is the sort of material through which the ground water of the region passes.

b. Water being pumped from well No. 60 by electric power.

thus been trapped far beneath the surface, accumulating for thousands of years. Any well drilled in this particular location, namely, in this syncline which enters the rock horizon in which the water is trapped and under pressure, will undoubtedly give artesian flow. Just how long such artesian water may last depends upon the source of supply, which has not yet been accurately determined; but which probably lies to the west and consists of meteoric waters, or that water which falls upon the surface of the ground and enters it, passing to a greater depth. The source of this water and the problem connected with this supply is an entirely different problem from that in the region of White Bluffs and Hanford.

In the fall of 1921 a second well was drilled by the same people one-half mile west of this first well and a similar flow of artesian water was obtained.

INTERPRETATION OF DATA

The elevation of the water in the wells at the time they were examined varied only within a narrow limit. The well in which the water was lowest in elevation (350 feet above sea level) is situated in the southern part of the area, near the river at its lowest point. The highest elevation of water in a well was 407 feet, and it is located in a place where there is undoubtedly a certain amount of leakage from the Hanford Irrigation Ditch. The average elevation of the level of the water in the wells measured was 381 feet.

The water table is the top surface of the zone in which the sands and gravels are saturated with water. Where this is reached in a well, the water will seep rapidly out of the surrounding gravel and fill up the well to the ground water level or the level of the water table.

The elevation of the water table was higher than the river level at the time the data were collected, as may be seen by studying carefully the accompanying map. This

feature may be accounted for by considering that the gravels were filled when the water in the river was high. Then the river fell rapidly and the ground water escaped more gradually through the alluvium. One particular point of discharge was in Section 23, Township 13, Range 27, where the water escaped as springs or seepages along the river bank and flowed back into the river.

The surface of the ground is shown by the contour lines and their elevation. The water table does not conform to the surface of the ground in detail over this area. The water table is independent of this feature and appears to be a fairly level surface.

Along the region bordering the Hanford Irrigation Ditch the water table was found to be higher than elsewhere, for the ditch leaked and its water saturated the ground locally. This water had gradually soaked into the ground and had joined the water table, forming a part of it. If the ditch had been left dry for some time it is quite probable that the level of this local water table would have been lowered and would have finally conformed to that of the rest of the area.

In order that a well may contain water it should be deep enough to pass through the ground water level, or water table. The wells of the area vary in depth—those on the higher points (topographically) are deeper to water than those on the lower points. Omitting the deeper wells (Nos. 169, 170, 171 and 158), the average depth to water, measured from the surface of the ground, was 28 feet for the wells sounded. In the case of Nos. 169, 170, and 171, where the depths to water were 141, 94, and 92 feet, respectively, the water elevation above sea level was 396 feet in each case, which was about the same as that in the other wells of the same district, and only 10 feet above river elevation taken at that time.

In the data list included in this report, comparison has been made of the water elevation in each well and

the river elevation at a point in the river nearest the well. This shows the position of the water table in reference to the stream which parallels, in a general way, the direction of flow of the underground water. The source of the water in each particular well, however, may be at a point considerably higher up stream than that point from which this river elevation was taken.

The amount of water in each well may be found by subtracting the depth to water from the depth to the bottom. The average depth of water was 7 feet in the wells sounded.

FLUCTUATION OF THE WATER TABLE

It is generally reported that the elevation of the water in the wells rises and lowers exactly with the rising and lowering of the river level, but not with as great a magnitude. The total fluctuation of the river level is about 20 feet during the entire year, while the fluctuation of the level of the water in the wells appears to be about 10 feet, although this latter information is not as definitely recorded as that of the river level. This indicates that the source of the underground water in the region of White Bluffs and Hanford is the Columbia River, which charges the gravels when it is high. As the river lowers, the gravels are drained and thus the water table is likewise lowered. The time of the rise of the water table is important in relation to the use of the water for irrigation purposes. The following curves explain graphically this relation. The fluctuation of the river level is compared with the amount of water which has been used for irrigation purposes from the ditch, which shows the two practically to coincide.

FLOOR OF THE GROUND WATER

From a study of the geological formations and their structure in this region, together with a study of the deep well at Ringold, general conclusions are thus

CURVES COMPARING
CONSUMPTION OF IRRIGATION WATER
TO
RISE OF WATER IN COLUMBIA RIVER 1920

FIG. 1. Curves comparing consumption of irrigation water to rise of water in Columbia River, 1920.

reached, relating to the nature of the material which underlies the alluvial plain.

If deeper wells should be put down in the immediate vicinity of White Bluffs and Hanford, they would probably pass through the sand and gravel of the old river flood plain at an elevation of approximately 300 feet above sea level.

After passing through the gravel of this old flood plain, clay and fine sand would probably be encountered, and this might be expected to vary in thickness, but underlying it in turn would undoubtedly occur basalt at an elevation of about 200 feet above sea level.

SEEPAGES AND FLOWING SPRINGS ON THE BANK OF THE COLUMBIA RIVER

For a half mile along the bank of the Columbia River (Section 23, Township 13, Range 27), seepages and flowing springs were issuing water, during the time they were visited, from the low bluff at a point ten feet above the river level and at an elevation of 365 feet. This elevation is only a little lower than the elevation of the water table in the vicinity of the seepages. The material from which they flowed consisted of clay, sand, and some gravel. Lying above this ground water discharge, were found 15 to 20 feet of alluvial material, such as sand, gravel, and soil. It may be noticed from a study of the map that the location of these seepages is only one-half mile below the point at which the proposed drain intersects the river bank. The proposed drain follows, in general, the surface swampy areas or seepage lands which lie parallel to the Hanford Irrigation Ditch. The drain as proposed is to carry off the surplus water which leaks from the irrigation ditch and forms local swamps along this area.

The water discharge of the springs on the bank of the Columbia River appear to be greater in quantity than

the water in the ditch. It is reported by persons whose observations can no doubt be trusted, that the seepages occurred before the irrigation ditch was constructed. It appears, therefore, that they represent the run-off from the general water table of the area. They may be charged to a certain extent by the leakage waters of the irrigation ditch, but they cannot come entirely from that source.

It is significant, therefore, that the Columbia River at this point at least, and probably along the bank for several miles, does not enter and does not charge these gravels at least during this particular time of the year. The elevation of these seepages, however, was lower by about 20 feet than the water level of the Columbia River in the region about Coyote Rapids. The level of the Columbia River at this time of the year is lower by nearly 20 feet than it was during the summer months. If the source of the water in the region is the Columbia River, the water must, therefore, enter the gravels at points upstream from the location of the seepage, and probably in the region above Coyote Rapids, where coarse alluvial gravels exist on the south bank such as in the region of China Bar. The intake area may also be below Coyote Rapids above the bend in the river.

The source of the water in these springs is, therefore, undoubtedly the same source as that of the underground water of this region. Since there is a 65 per cent loss by leakage and evaporation from the irrigation ditch, the supply may partly be affected by the leakage from the irrigation ditch and from additional seepage from the irrigation waters taken from the ditch and placed on the land where it soaks rapidly into the ground again.

SOURCE OF THE UNDERGROUND WATER

PRINCIPAL SUPPLY

The principal supply of the underground water of this area is undoubtedly from the Columbia River. The evidences of this are: (1) That the ground water level or water table fluctuates with the river. (2) That the elevation of the water table corresponds with the elevation of the river. (3) That the composition and structure of the materials of the alluvial plain would allow water from the river during its higher periods to enter the gravels. (4) That the gravels lie in the old channels of the ancient river, leaving natural underground seepage channels to exist.

SECONDARY SUPPLY

A secondary source of supply is that of the meteoric waters or that water which falls as rain or snow upon the surface of the ground. This source is quite small.

LOCAL SUPPLY

In addition to this supply the leakage water from the Hanford Irrigation Ditch undoubtedly adds to the ground water of the region. Material effect from this is principally in the zone immediately bordering the canal. It is recorded that 65 per cent of the water which goes into the ditch is lost by evaporation and leakage. All the water used for irrigation that is not lost through evaporation, enters the ground and adds to the ground water supply.

POSSIBLE SUPPLY

There is another possible source of the ground water. This is a possible ascending leakage from an artesian supply below. An artesian basin exists in the region of the *syncline in basalt* indicated on the map—near the present

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flowing artesian well. Such trapped waters might possibly enter into the upper ground water zone by upward penetration through openings in the rocks from pressure of the trapped artesian below. This, however, would not probably affect the region under consideration because it lies north of Gable Mountain, which would serve as a barrier to such migration of waters.

RECOMMENDATIONS

LOCATION OF WATER WELLS FOR IRRIGATION

Before wells are dug in the future, in the vicinity of White Bluffs and Hanford, the accompanying map, as well as this report, should be consulted, but unless correct interpretation is made, this map can be of little use. In the first place, the depth of water, which should be encountered in a well, will vary according to the varying level of the water table of the district. The elevation of the water table as given in the present wells and shown on this map refer only to the position of the water table during the time interval in which the data were collected. Two elevations should be obtained before a new well is dug: (1) the elevation of the surface of the ground at the point at which the hole is to be drilled, and (2) the elevation of the water level in the older wells of the neighborhood. The depth of the hole necessary to encounter water would have to be the difference between the surface elevation of the ground and the elevation of the water level thus obtained. The depth of the water necessary in the well should be great enough to insure water during the entire year. This would mean that if water is obtained in the well when the water table is at its lowest level, there will be assurance of an abundant supply of water in the well, for purposes of irrigation, at the time when the water table is at its highest point. Before a well is drilled, therefore, the time of year and the height of the river should be considered in relation to the information given in this report.

There may be a few cases in this territory in which the wells will not prove satisfactory on account of local conditions. These local conditions might consist of local deposits of clay which might cut off or deviate to a certain extent the migration of underground water. Before

poor wells are thus accounted for, however, exact information regarding the proper elevation of the water table at that particular place should be obtained and a comparison made to the elevation of the depth of the poor well, so that there would be assurance that the well had penetrated the water table level.

UP-KEEP OF THE WELLS

In order to insure decent conditions over this entire area, the wells should be kept in good condition or sealed off entirely. In the first place, safety should be considered vital. In a great many cases the present wells are very unsafe in that they are not properly covered, or the entrance is not properly guarded, so that children as well as stock may easily fall into them.

Another important feature is that of sanitation. If one well is polluted, it is quite possible that other wells, especially those in the immediate vicinity, will be infected from this first well. The underground water passes through sands and gravels and is filtered to a great extent, but since it is known to pass rapidly through very large interstices between the boulders, it might readily carry bacteria and germs of various sorts. Although this feature has not been accurately examined, it should be taken into careful consideration, especially since further settlement of this territory is to be made by soldiers and their families. A number of the wells at the present time contain dead animals, such as jack rabbits, which give rise to conditions which are at least unsanitary.

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**DEPARTMENT OF CONSERVATION
AND DEVELOPMENT**

DIVISION OF GEOLOGY

BULLETIN No. 26

PLATE 1

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R. 25 E.

R. 26 E.

R. 27 E.

STATE OF WASHINGTON
DEPARTMENT OF CONSERVATION AND DEVELOPMENT
D. A. SCOTT, DIRECTOR
DIVISION OF GEOLOGY
S. SHEED, SUPERVISOR

MAP OF
WHITE BLUFFS HANFORD DISTRICT
SHOWING FEATURES RELATING TO
UNDERGROUND WATER SUPPLY

PREPARED BY
CLAY P. JENNINS
GEOLOGIST IN CHARGE
1921

Data taken from maps prepared by Hanford Irrigation Project,
U.S. Bureau of Reclamation and U.S. Geological Survey.

LEGEND

- Domestic well.
- Irrigation well.
- Vertical number above well (1 to 100)
arbitrarily taken for reference.

Starting number below well is elevation
of water surface in well during October,
19 to 25, 1921, determined by sounding
well and comparing topographic elevation
of surface of well from data given on
topographic maps.

- State lands to be considered
- Private lands to be considered

Irregular ditch lined

Irregular ditch not lined (arbitrary)

Probable axis of anticline

Probable axis of syncline

Contact between gravel river gravel
bed and old alluvial flood plain

Contact between basalt and alluvial
flood plain

Contact between basalt and lake bed
formation

Contact between lake bed formation
and alluvial flood plain

Scale
1 inch = 1 mile

250' contour
from
U.S.S. Maps

10 ft. contour
from
U.S.S. Maps

10 ft. contour
from
U.S.S. Maps

SHOWING LOCATION OF
WHITE BLUFFS HANFORD DISTRICT

T. 14 N.

T. 14 N.

T. 14 N.

T. 13 N.

T. 13 N.

T. 13 N.

R. 24 E.

R. 25 E.

R. 26 E.

R. 27 E.

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