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CHEMICAL EFFLUENTS TECHNOLOGY WASTE DISPOSAL INVESTIGATIONS

JULY, AUGUST, SEPTEMBER, 1957

Prepared by Members of the

Chemical Effluents Technology Operation

Edited by: D. J. Brown

December 27, 1957

CHEMICAL RESEARCH AND DEVELOPMENT OPERATION
HANFORD LABORATORIES OPERATION

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

Operated for the Atomic Energy Commission by the
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CHEMICAL EFFLUENTS TECHNOLOGY WASTE DISPOSAL INVESTIGATIONS

JULY, AUGUST, SEPTEMBER, 1957

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CHEMICAL EFFLUENTS TECHNOLOGY WASTE DISPOSAL INVESTIGATIONS
JULY, AUGUST, SEPTEMBER, 1957

INTRODUCTION

The Chemical Effluents Technology Operation is assigned to investigate the radiological aspects of environmental contamination resulting from plant effluents or from potential process disasters. This report is primarily concerned with plant assistance research in the field of waste disposal during the quarter July, August, September, 1957.

The ground-water monitoring data utilized in this report were obtained from well water samples. These samples are collected routinely by the Regional Monitoring Operation and analyzed by the Radiological Chemical Analysis Operation.

I. INTERPRETATION OF GROUND-WATER MONITORING DATA

200-East Area

Test wells monitoring the ground water and contained contaminants in and adjacent to the 200-East area showed no significant change during the past quarter. The extent of contaminated ground water movement is shown in Fig. 1 by outlining the 1.5×10^{-7} μc/cc limit for gross beta activity.

Low-level contamination, reaching the ground water in the vicinity of the 216-BY and 216-B crib sites, moves westward down the hydraulic gradient. West of the 200-East area fence this contaminated ground water intercepts a buried, north-south trending channel of highly permeable sands and gravels. In this channel the ground water moves to the north and south.

Fig. 1 also shows the extent of ground-water contamination from the 216-A-8 crib. This crib is located directly east of the 200-East area and receives condensate from the 241-A Tank farm.

Results from isotopic analyses made on the ground water beneath the 216-BY cribs continue to show the presence of Co^{60} in concentrations exceeding the maximum permissible concentration in drinking water for nonoccupational consumption. The concentration of this isotope in the ground water has, however, shown a gradual decrease from 1.5×10^{-3} μc/cc to 5×10^{-4} μc/cc. A continued decrease in the concentration of Co^{60} is expected as the amount of liquid wastes from these cribs draining into the ground water decreases.

Fission product analyses showed no detectable concentration of radioactive Sr^{90} or Cs^{137} in test wells monitoring the cribs within the 200-East area.

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Ground-water Contamination from the 200-East Area Crib Sites.

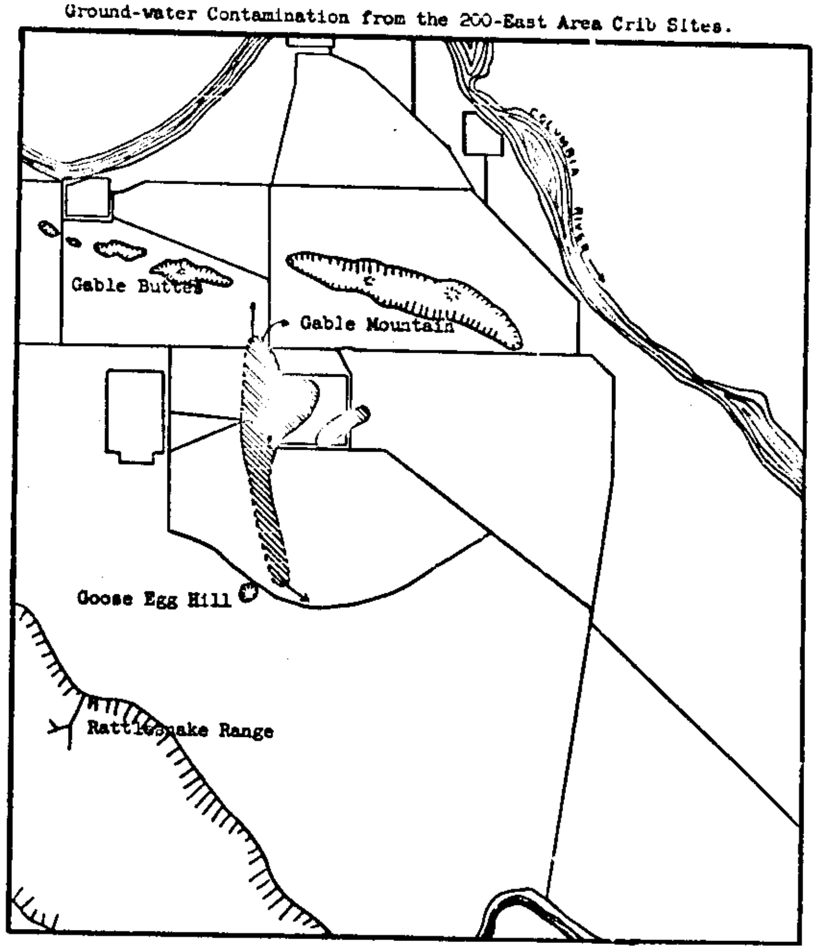

Fig. 1

Contamination pattern as of September 1957 depicted by outlining the 1.5×10^{-7} µc/cc ground-water contamination limits.

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200-West Area

Radioactive liquid wastes reaching the ground water from cribs located in the 200-West area showed no significant change in the rate of movement from that of the last quarter. However, four new monitoring wells drilled in the southeastern section of the 200-West area provided sufficient data on the ground water to indicate that the ground-water contaminated by the 216-WR cribs is more extensive than previously thought. Fig. 2 shows the location of the four new wells and the ground-water contamination patterns in the vicinity of the T-plant, Redox plant, and east of the 216-WR cribs. For comparative purposes Fig. 2 also shows the previous quarter's contamination pattern, east of the 216-WR cribs, superimposed on this quarter's map (1).

Well 299-W22-2, located adjacent to the 216-S-1 crib, showed positive Sr^{90} concentrations in the ground water for the fifth consecutive month. The activity density of Sr^{90} in this well remained approximately 1.0×10^{-6} $\mu c/cc$. No other samples from monitoring wells in the 200-West area contained detectable concentrations of either radiostrontium or radiocesium.

II. PLANT WASTE DISPOSAL PRACTICE

Chemical Processing Department

Eleven batches of waste have been processed by CPD in 200-East area since in-farm scavenging was resumed in March, 1957. Seven batches containing Co^{60} concentrations above the recommended cribbable limit of 4×10^{-4} $\mu c/cc$, and two batches demonstrating poor cesium soil adsorption characteristics were discharged to the 216-BC specific retention trenches. Two batches meeting crib disposal criteria were disposed of to the 216-BC-6 crib.

The monitoring and test wells requested in HW-50170, Test Wells -- 216-BC Crib Area (5), has been delayed due to tie-up of construction fund appropriations. Money for this project is not expected to be available until late 1957.

Final analyses of moisture loss from a bed of aluminosilicate gel placed on top of a soil column indicates that a one-foot thick layer of gel will lose sufficient moisture to wet five feet of soil to its specific retention capacity. The final gel was 45% water by weight and occupied a volume of approximately 30% of the original volume. The relatively high loss of moisture to the soil indicates that successful disposal of coating removal waste as a gel will need to satisfy one or possibly both of the

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Ground-water Contamination from the 200-West Area Crib Sites

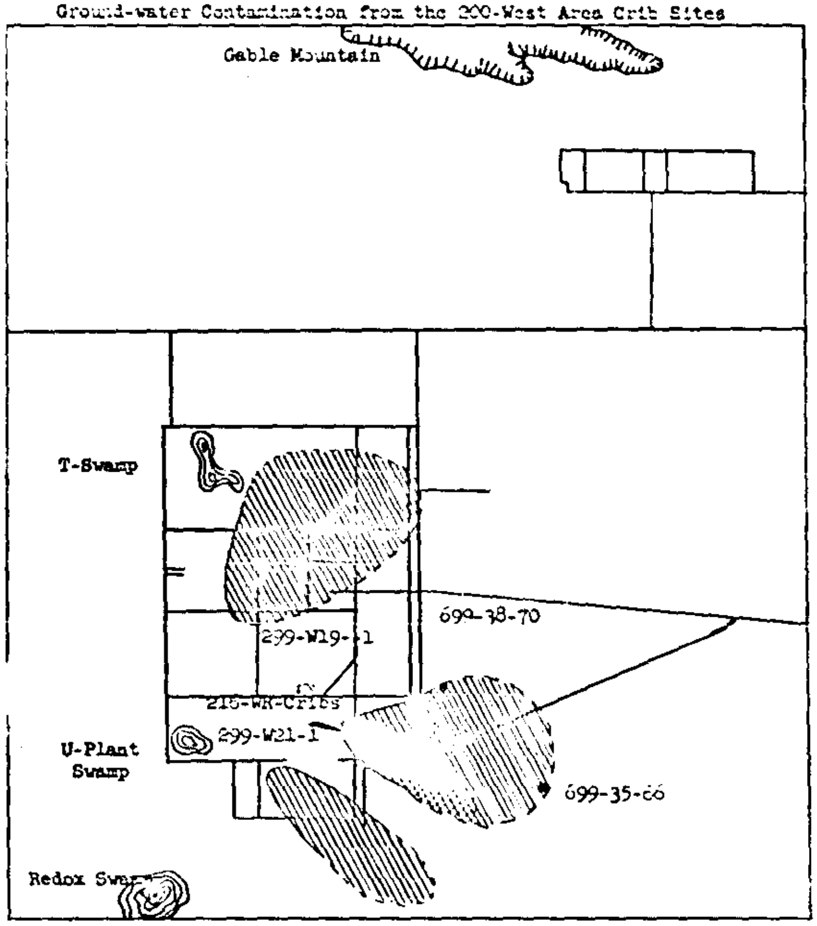

Fig. 2

Contamination pattern as of September 1957 depicted by outlining the 1.5×10^{-7} µc/cc ground-water contamination limits.
The 1.5×10^{-7} µc/cc ground water contamination limit as of June 1957.

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following conditions:

1. Essentially all of the radioactivity (greater than 99%) will need to be held in the gel.

2. Radioactivity in moisture lost to the soil will need to be nearly completely adsorbed by the soil immediately under the gel.

Approximately 200 gallons of gelled "cold" aluminum waste were discharged to a pit east of the 300 Area on September 24, 1957. The disposal, which was conducted at an average discharge rate of ten gallons per minute, approximated the rate at which coating waste is produced by prime separation plants. Good in-line continuous mixing and discharge achieved at both high and low flow rates resulted in the formation of a firm product having a gelation time of about 1.5 minutes. Localized gelation in the mixing nozzle was noted in several instances, but did not interfere with mixing or pumping. Additional samples and measurements will be taken during the next several months to evaluate moisture loss and gel shrinkage.

A study was made which investigated the possibilities of extending the studies on the coating waste gelling process to include high level wastes. The work was primarily directed towards defining a few of the problems that may be encountered, the variables involved, and outlining any studies that should be initiated. Document HW-51682, Thermal Considerations In The Disposal of Gelled High Level Radioactive Wastes (7), was issued.

Fuels Preparation Department

HW-52401, Dilution of 300 Area Uranium Wastes Entering the Columbia River, issued September 3, 1957 (6), defines the extent of dilution afforded 300 Area uranium wastes by the Columbia River. Analyses of river water and waste pond samples showed that the uranium concentration in the river at the Hanford boundary is less than 1/500th (essentially background) of the concentration in the pond.

Irradiation Processing Department

Efforts to evaluate the disposal aspects of Turco 4306-B, when used as a decontaminating agent for the internal surfaces of a reactor's rear face piping, continued. In order to make this evaluation, help was solicited and received from several organizations.

Aquatic Biology Operation determined that the disposal of the spent cleaning solution to the river would have little or no effect on the

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local Chinook salmon. The water treatment laboratory of the Irradiation Processing Department determined that the Turco would have no effect on either the processing of the coolant or the quality of the coolant of reactors downstream from the release point.

The Irradiation Processing Department initiated a trial decontamination at 105-H on September 23, 1957, which was supported by a disposal evaluation program. This program consisted of monitoring the effluent during the cleaning operation with a pH meter and sampling of the effluent and the river. The disposal method used depended on river dilution to reduce the concentrations of both the radioactive material and the chemically toxic material to insignificant levels at sources of human drinking water downsteam. The sampling and analytical plan was devised to permit comparison of disposal consequences of the cleaning operation during a reactor outage with the disposal consequences of normal operating reactor's coolant. The results of this disposal evaluation program are expected to be reported in some detail in a document to be issued in mid November.

A single experiment was performed to estimate the uranium present on the exterior of fuel elements, and thereby evaluate the uranium as a potential source of Np^{239} in reactor effluent. The limited data show that about 3-4 micrograms per slug could be removed by leaching with nitric acid. About one microgram per slug was removed by swabbing with a wet paper towel. Calculations from these analytical results indicate that uranium from the slug surfaces is making relatively little contribution to the Np^{239} in the effluent.

A program was initiated to determine the influence that cladding fuel elements with M-388 alloy would have on reactor effluent activity. This alloy has slightly more nickel and iron than the standard alloy used for jacketing Hanford slugs and is believed to be more resistant to intergranular corrosion, a cause of ruptured slugs. Changing the slug cladding might change the characteristic process tube holdup time of parent isotopes in the coolant or change the corrosion products in the effluent. Effluent sampling taps were installed on two process tubes at 105-KE. Both tubes were charged on July 8, 1957, one with M-388 slugs and the other with Hanford regular slugs. The tubes are scheduled for discharge on October 18, 1957. Effluent samples (5 pairs) have been and will be taken periodically in the interim and analyzed for twelve different isotopes or isotopic groups. Although the analytical work has not been completed, initial results show no significant difference in the concentration of any of the isotopes in the two streams, which indicates that the change in cladding had little effect on effluent activity.

As a first step in planning experiments designed to produce data on fraction of fission products released in event of a reactor disaster,

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a literature survey was made to determine the extent of present knowledge in this field. The survey is being issued as a formal report, HW-52753.

An experimental procedure was scoped and the proposed methods were discussed by interested parties. Laboratory equipment required for the tests was ordered.

III. LABORATORY EVALUATION OF WASTES

Soil column experiments continued to be the primary basis for laboratory evaluation of plant wastes. The emphasis of laboratory effort was shifted to a study of capacities of cribs and underground caverns currently receiving wastes from the Purex and Redox plants. Samples of seven batches of scavenged waste were tested in the laboratory. Because the soil is virtually ineffective for removing Co^{60} a waste is usually not discharged to a crib unless this isotope is reduced by scavenging to a concentration below 4×10^{-5} µc/cc. During the "use" test of the 216-BY cribs (7) this concentration limit is increased by a factor of ten to a value of 4×10^{-4} µc/cc. Five batches of the waste were disqualified for crib disposal as a result of Co^{60} concentration. They are listed with their Co^{60} concentrations in Table I.

TABLE I

SCAVENGED WASTES TOO HIGH IN Co^{60} FOR CRIB DISPOSAL

	Batch No.	Co^{60} µc/cc
1.	13-109C-102 BY	5.1×10^{-3}
2.	14-119C-102 BY	3.5×10^{-3}
3.	17-111C-103 BY	1.9×10^{-3}
4.	18-111C-103 BY	4.8×10^{-3}
5.	19-109C-101 BY	4.6×10^{-4}

The two remaining batches of scavenged waste met the Co^{60} requirement. Laboratory column tests showed that these demonstrated sufficient strontium and cesium adsorption by the soil to warrant crib disposal. Calculations showed that both batches consumed only a small part of the crib capacity. More than two column volumes of one batch and more than four column volumes of the other passed through laboratory soil columns before breakthrough occurred. Table II is a summary of these results.

TABLE II

216-BC-6 CRIB RECEIPTS FOR THIRD QUARTER

	Batch No.	Vol-gal.	Calculated Capacity in Column Volume Units	
			Cs^{137}	Sr^{90}
6.	15-112C-101 BY	450,000	> 2	> 2
7.	16-109C-101 BY	245,000	> 4	> 4

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Four cribs at the BC disposal site including 216-BC-2, 3, 5, and 6, are simulated in duplicate by 40 cm. x 1.9 cm. standard laboratory soil columns. Batches of waste that have already been disposed of through these cribs were synthesized in the laboratory and discharged to these columns. Crib numbers 1 and 4 were omitted because the quantity of Co^{60} which these installations have received is not known, thus making them less valuable than the others for the cobalt "use" test. Moreover, these four cribs still have a much greater capacity than is required to receive the remaining scavenged waste. Table III gives the disposal history to date for the active cribs.

TABLE III

SUMMARY OF WASTE DISPOSAL TO BC CRIBS THROUGH THE THIRD QUARTER 1957

Batch No.	Crib No.	Vol-gals.	Fraction Col-vol.	Measured Volume to Breakthrough (Column Volume) Cs^{137}	Sr^{90}
27-106 BY	1	577,500	.14	3	3
22-110 BY	1	550,000	.14	1	1
23-107 BY	1	591,250	.15	3	3
24-108 BY	1	572,000	.14	3	3
30-106 BY	2	580,250	.15	3	3
31-107 BY	2	24,750	.06	2	3
32-108 BY	2	583,000	.15	2	3
29-110 BY	3	519,750	.13	3	3
31-107 BY	3	513,500	.13	2	3
6-112C-105C	3	445,500	.11	1	3
1-112C-109C	4	452,400	.11	1	3
2-109C-101C	4	437,250	.11	1	1
25-110 BY	5	547,250	.14	3	3
26-106 BY	5	558,250	.14	3	3
27-107 BY	5	556,875	.14	3	3
28-108 BY	5	585,750	.15	3	3
52-108 BY	6	511,500	.13	3	3
15-112C-101 BY	6	450,000	.11	2	2
16-109C-101 BY	6	245,000	.06	4	4

Current schedules call for completion of the scavenged waste program by the end of 1957. As a result it was possible to put more effort on the appraisal of capacities of disposal facilities receiving other wastes generated at the Purex and Redox separations plants. Multiple column tests of Purex A-8 are being continued. Interpretation of soil column data was accomplished by extrapolation. It was found that the logarithm of the volume of effluent is a linear function of the cumulative normal

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distribution of C/C_o. Thus this extrapolation became of possible use. Initial calculations indicated that the Purex A-8 crib might not be usable beyond January 1958 (9). A study of the effect of such variables as temperature, component concentrations, flow velocity, nature of soil, etc. on the uptake of radioisotopes by the soil is in progress. A more reliable basis for calculating crib capacities may be developed from the results of this study (10).

IV. REGIONAL HYDROLOGY

Fig. 3 is a map showing contours on the water table as of June 1957. As shown, points A, B, and C are wells located near the T, U, and B-swamps, respectively, which thus monitor the known peaks of the 200-West and 200-East ground-water mounds. This map may be compared with the contour map of October 1956, Fig. 4. The peak of the 200-West mound at well B has reached approximate equilibrium at an altitude of about 475 feet above mean sea level. The water level in well A fell about 5 feet during the 8-month interval as a continued result of last year's drastic reduction of cooling water discharged to the T-swamp. The southern part of the 200-West mound has flattened out, influenced probably by the buried extension of the Yakima Ridge which locally rises above the water table and impedes the southward movement of the ground water. The peak of the 200-East mound is now defined at an altitude of over 417 feet as determined in a recently surveyed well located about 1 mile south of well C. The water level in well C has risen about 5 feet.

The form and extent of the zone of sediments artificially saturated by plant effluents which reached the water table between January 1944 and June 1957 are shown in Fig. 5 by contours representing lines of equal ground-water rise. These changes are ascribed entirely to plant operations. The total volume of sediments thus affected was determined by graphical integration to be roughly 62 billion cubic feet. Assuming all of the process effluent wasted to ground since 1944 is still in the depicted zone (none discharged to the Columbia River), the above volume of sediments was saturated with about 30 billion gallons of water, or about 4 billion cubic feet. Thus, the average wetted porosity of the sediments is approximately 6.4 percent. Carrying this procedure further, it is estimated that those sediments affected by the 200-East ground-water mound have an average wetted porosity of 7.2 percent and those affected by the 200-West mound have a value of 6.0 percent.

In order to further define the hydraulic characteristics of Hanford aquifers (8), five additional pumping tests were completed. The draw-down-recovery data were interpreted graphically and the results are included in Table IV which summarizes the results of all tests completed

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to date.

TABLE IV

	Aquifer tested	Well No.	Transmissibility (gpd/ft)	Permeability (gpd/ft^2)
(A)	Ringold formation			
	Lower clay portion	699-40-33	1,600	10
	Middle conglomerate	*699-47-35	3,000	150
		199-K-10	34,000	400
	Upper silty portion	699-71-72	35,000	900
		699-40-24	210,000	1,400
(B)	Mixed aquifers			
	Uppermost Ringold and	199-F7-1	59,000	3,900
	lowermost glaciofluviatile	*699-77-54	318,000	4,500
(C)	Glacio-fluviatile deposits	699-62-43	350,000	12,700
		699-65-50	480,000	13,700
		*699-31-30	1,850,000	20,500
		*699-14-27	2,000,000	[illegible]
		*699-24-33	2,900,000	64,500
		699-55-50	3,000,000	66,700

*Newly reported

It is obvious that the hydraulic characteristics both within a given aquifer and between different aquifers differ widely. However, orders of magnitude for permeability are indicated for particular strata which permit correlation with other geologic and hydrologic data for the identification of areas of rapidly moving ground water.

Fig. 6 is a map showing the general direction and average rate of ground-water movement by vector arrows. These are based on hydrologic and hydraulic data which include the June 1957 contour map (Fig. 3), determination of an average effective porosity based on the newly saturated zone of sediments (Fig. 5), determinations of permeability (including those in the above table), and the results of a fluorescein tracer test. Areas of immediate concern are those showing rapid ground-water movement eastward along the northern flank of Gable Mountain and southeastward from 200-East Area.

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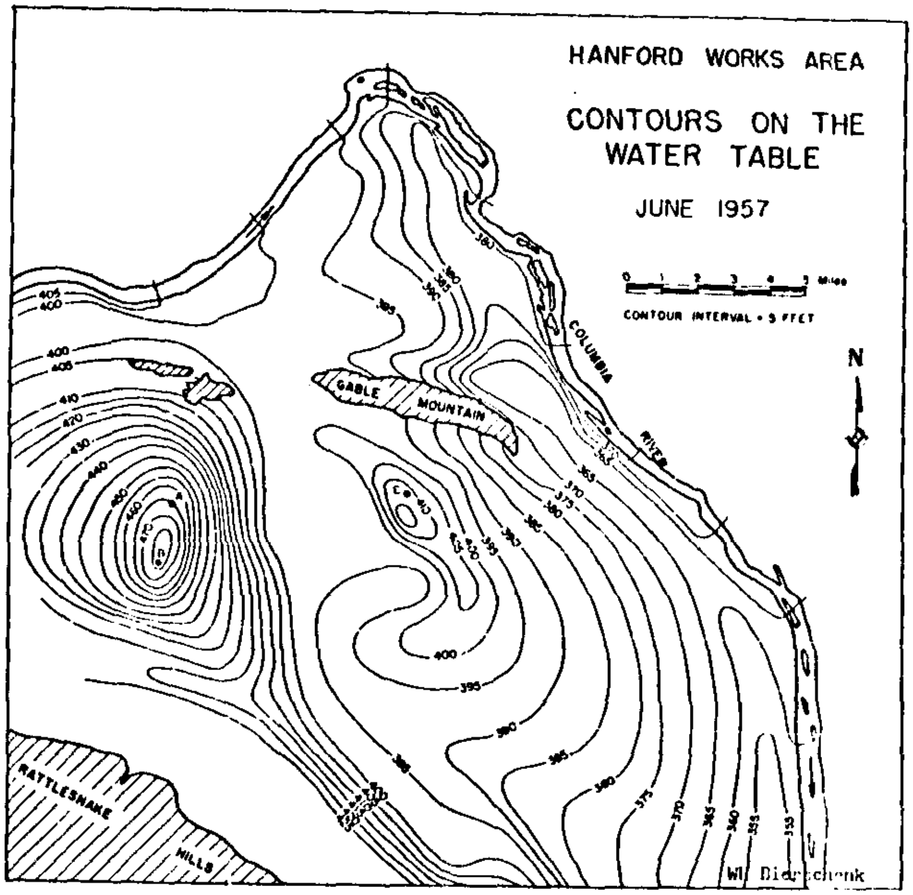
HANFORD WORKS AREA
CONTOURS ON THE WATER TABLE
JUNE 1957
CONTOUR INTERVAL = 5 FEET
N
COLUMBIA
RIVER
GABLE
MOUNTAIN
RATTLESNAKE
HILLS
Bierschenk

FIG. 3

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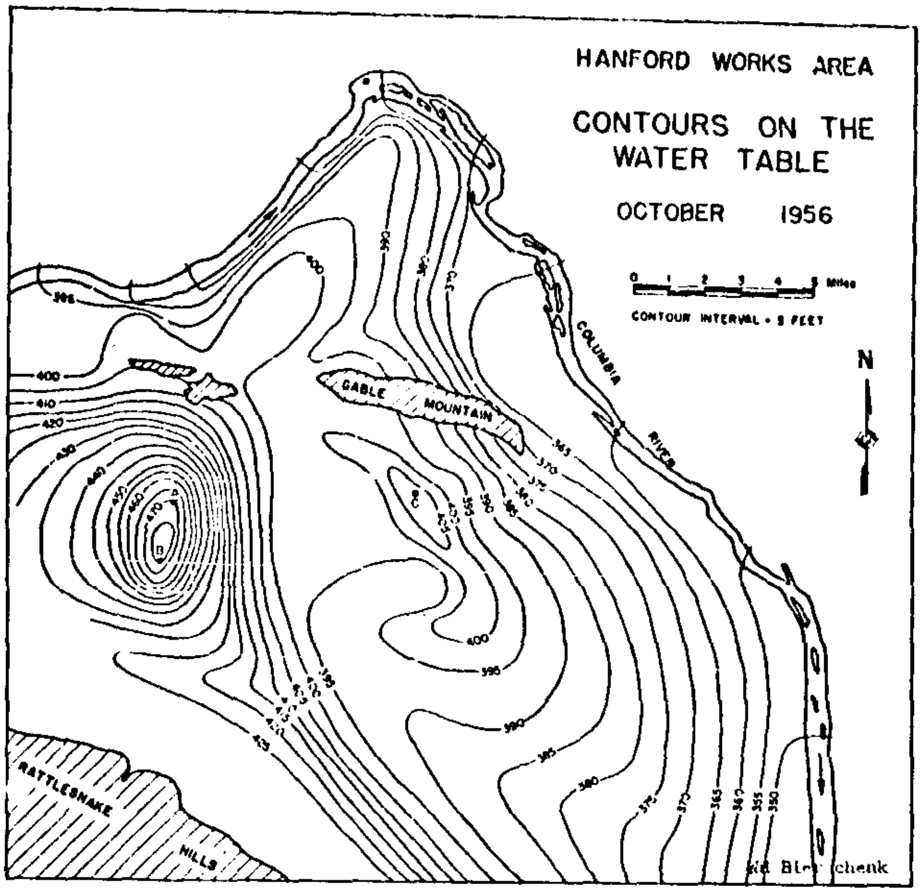

Fig. 4

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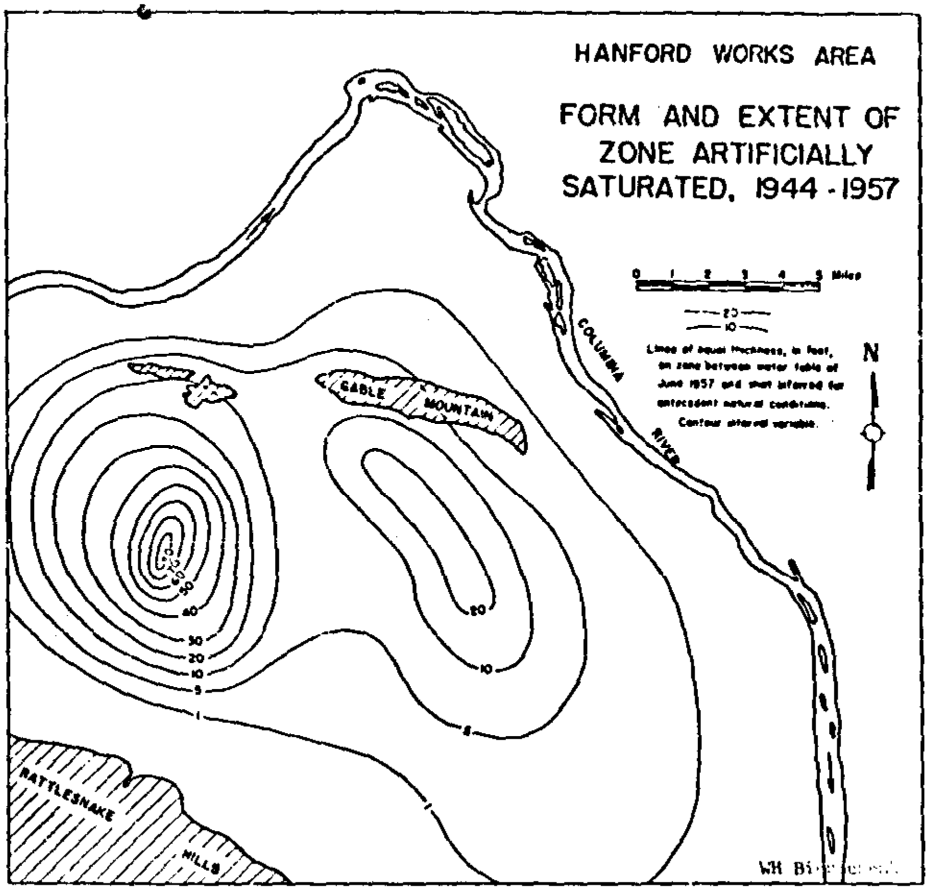

Fig. 5

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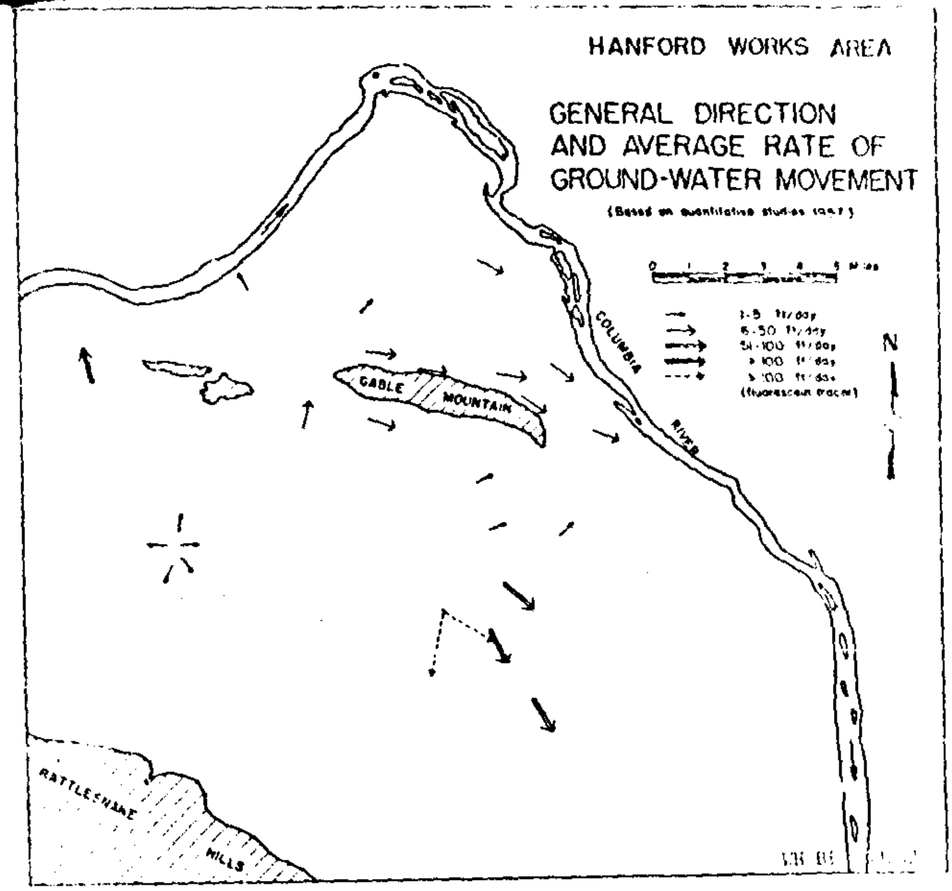

Fig. 5

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V. WELL DRILLING SUMMARY

TABLE V

WELL DRILLING SUMMARY

Third Quarter 1957

U.S.G.S.

Well	Ft. Drilled	Finished	Total Feet	To Water?
699-32-72	330	7/30/57	580	Yes
299-W6-1	411	8/5/57	476	" "
299-W15-86	144	8/14/57	144	No
299-E32-1	283	8/19/57	283	Yes
299-E28-8	315	9/11/57	315	" "
	1483		1798	

Hatch Drilling Co.

Well	Ft. Drilled	Finished	Total Feet	To Water?
699-30-65	127	7/11/57	450	Yes
699-32-70	108	8/7/57	350	" "
699-10-45	380	8/16/57	360	" "
299-W19-2	300	8/29/57	300	" "
299-W19-3	303	9/20/57	303	" "
299-W21-1	352	9/6/57	352	" "
299-W22-21	300	9/18/57	300	" "
	[illegible]		2435	

Drilling crews of the U.S.G.S. completed five wells of the CA-700 drilling project during the third quarter of 1957. The original contract calling for 13 test wells to be drilled by the U.S.G.S. was revised to bring the total to 16 (12). The number of wells now completed is 12. The total footage drilled to date is 4,676.

The Hatch Drilling Company has completed 15 wells on the CA-700 drilling project. These wells represent a total footage of 4,200 feet. A loss of approximately one month drilling time resulted from faulty welds in well casing received from the manufacturer. However, the Hatch Drilling Company is still slightly ahead of the time schedule specified in the CA-700 Contract.

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