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TITLE
CHEMICAL EFFLUENTS TECHNOLOGY WASTE DISPOSAL INVESTIGATIONS - OCTOBER, NOVEMBER, DECEMBER, 1956

AUTHOR
Chemical Effluents Technology Operation Personnel

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CHEMICAL EFFLUENTS TECHNOLOGY WASTE DISPOSAL INVESTIGATIONS

OCTOBER, NOVEMBER, DECEMBER, 1956

Prepared by Members of the

Chemical Effluents Technology Operation

Edited by: D. J. Brown

May 14, 1957

CLASSIFICATION CANCELLED

Per W. A. Snyder 3/26/74

By L. Pope 3/28/74

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RICHLAND, WASHINGTON

Operated for the Atomic Energy Commission by the
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RICHLAND, WASHINGTON

PRELIMINARY REPORT

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CHEMICAL EFFLUENTS TECHNOLOGY WASTE DISPOSAL INVESTIGATIONS

OCTOBER, NOVEMBER, DECEMBER, 1956

TABLE OF CONTENTS

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CHEMICAL EFFLUENTS TECHNOLOGY WASTE DISPOSAL INVESTIGATIONS
OCTOBER, NOVEMBER, DECEMBER, 1956

INTRODUCTION

The Chemical Effluents Technology Operation has among its functions the direct support of plant waste disposal activities and certain protection of plant and personnel activities. This report concerns the results of this kind of assistance during October, November, and December, 1956.

Monitoring data utilized in this report were supplied by the Regional Monitoring Operation, who collected the well samples. The samples were analyzed by the Radiological Chemical Analysis Operation All components of the Chemical Effluents Technology Operation have contributed to the results reported.

I. INTERPRETATION OF GROUND-WATER MONITORING DATA

200-East Area

During the fourth quarter of 1956 the 200-East ground-water mound showed an increase in elevation of 2.4 feet. Thus the westward gradient of the ground water beneath 200-East disposal sites became more pronounced. This has shifted the contaminated ground water to the west. Near the end of the quarter the contaminated zone tended to spread to the north and south. In the north the contamination is apparently moving around the western edge of the natural basalt barrier located north of the 200-East Area. In the south the contaminated ground water has been shifted to an area favorable for southward movement between the water mounds beneath 200-East and 200-West Areas. In Figure 1 the contamination patterns for October and December are depicted by outlining the 1.5×10^{-7} μc/cc ground-water contamination limits.

Radioactive material from wastes discharged to the 216-A-8 crib reached the ground water for the first time during the quarter. The first date of appearance was between the first and twelfth of December. No breakthrough of long-lived isotopes has been observed. Soil column tests have indicated that Sr^{90} will probably be the first such isotope to reach the ground water.

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

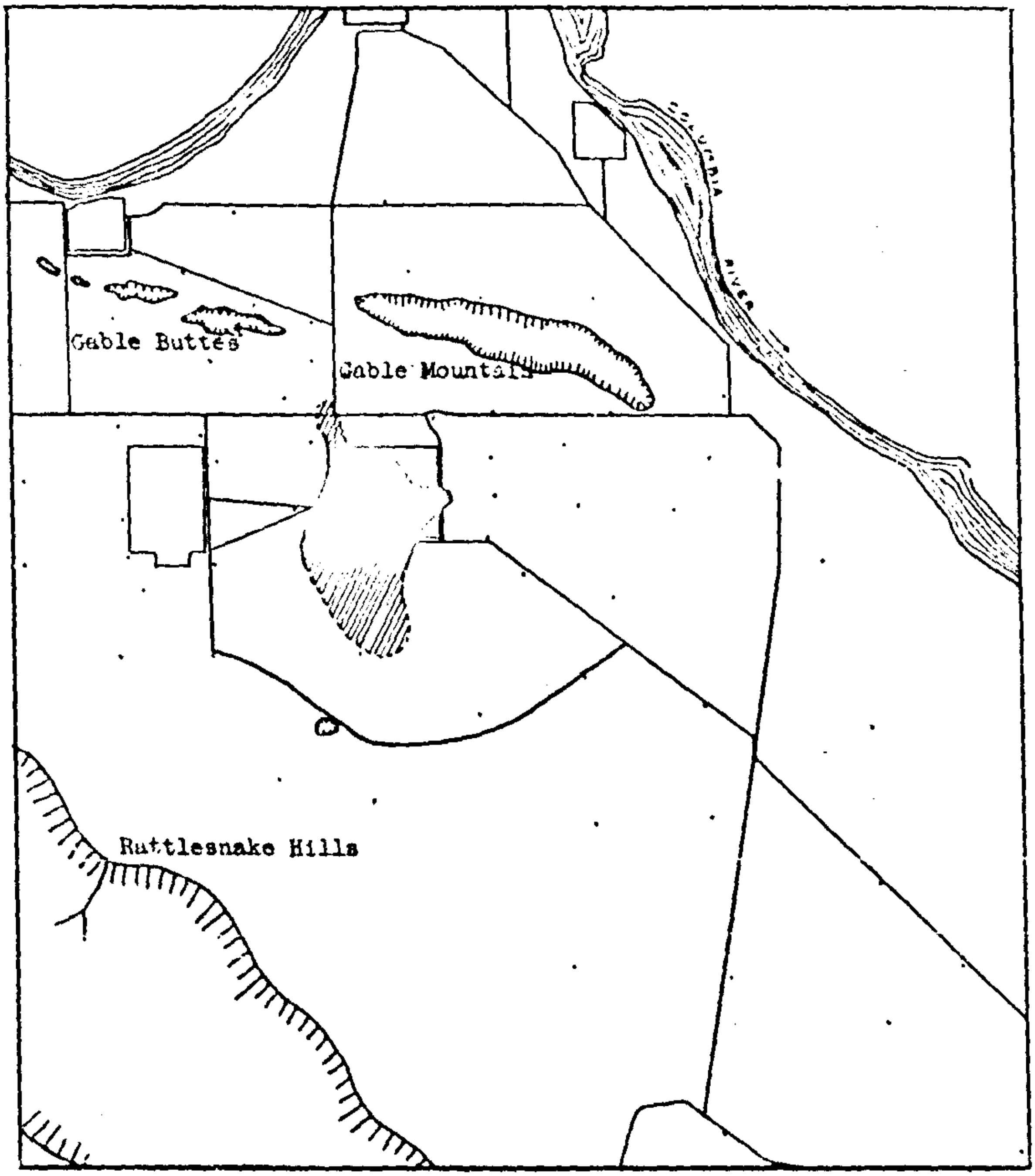

Figure 1.

December 1956
October 1956

Approximate extent of contaminated ground water.

 [redacted]

200-West Area

Results from test wells monitoring the ground water in the vicinity of the 200-West Area, indicate no significant change in the ground-water contamination patterns during the past quarter. Figure 2 illustrates the approximate extent of ground-water contamination from cribs located within the 200-West Area. The 1.5×10^{-7} uc/cc limits are used to depict the ground-water contamination pattern.

The slow change in the contaminated ground-water patterns in the 200-West Area is primarily the effect of fine-grained Ringold sands, silts, and clays which have relatively low permeabilities. This results in a mean ground-water velocity (vertical average) of 2 to 4 feet per day although in some zones higher velocities have been detected. The relatively low average velocities would result in a movement of between 180 and 360 feet in a three-months period.

 [redacted]

Ground water contamination from the 200-West Area Crib Sites.

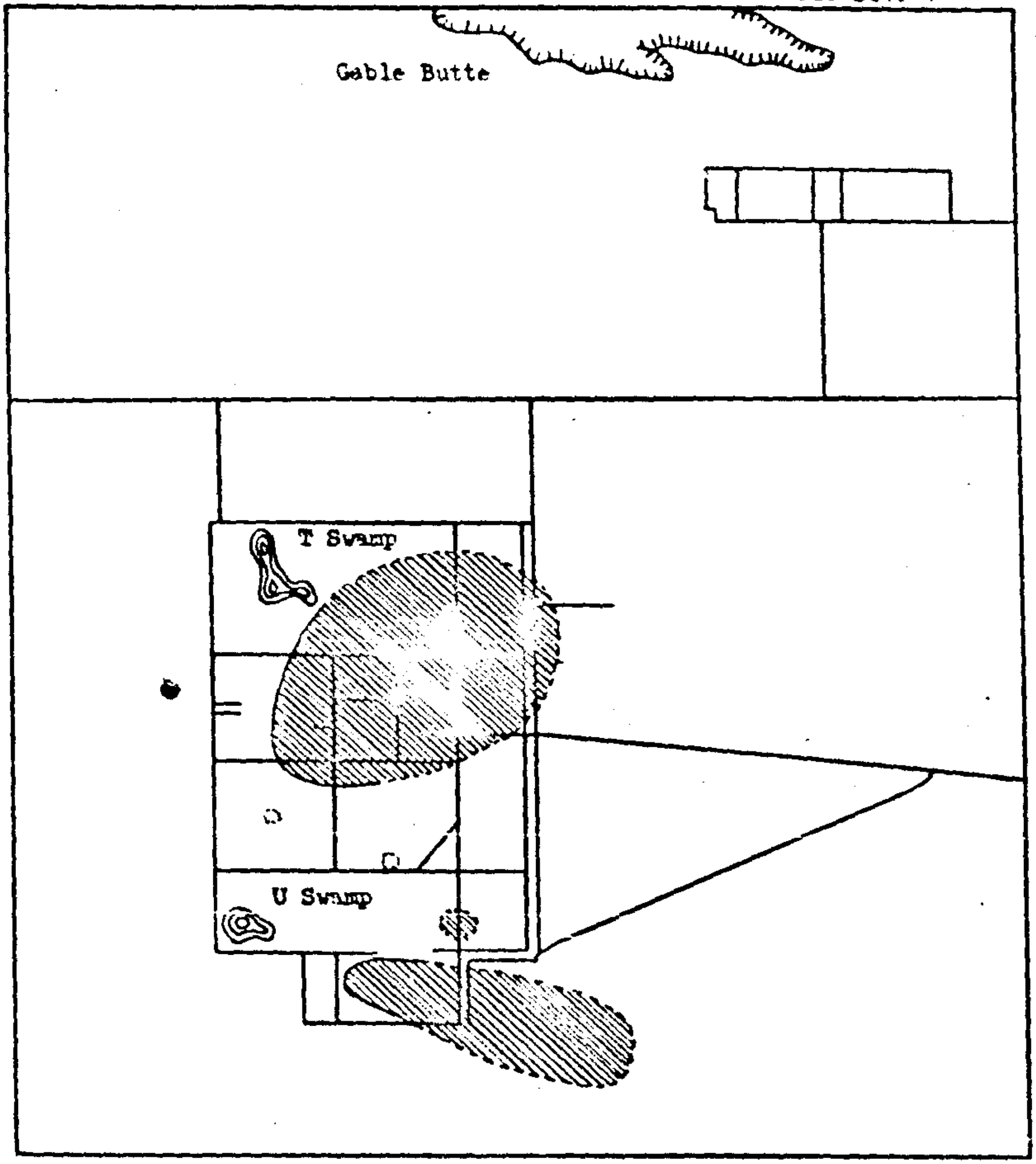

Figure 2.

Approximate extent of contaminated ground water, December 30, 1956.

[redacted]

II. PLANT WASTE DISPOSAL PRACTICE

Chemical Processing Department

A theoretical evaluation was made to determine the maximum leak from an underground storage tank which could occur without radioisotopes entering the regional ground-water table beneath the tank. The leak was considered as a point source, and the analogy between seepage flow pattern and stress distribution pattern in a loaded homogeneous soil mass was utilized in arriving at the shape of the wetted volume. Results of this evaluation indicate a total leak of approximately 150,000 gallons can be tolerated. Because of the limited experimental data applicable to the problem it will be recommended that a 50,000 gallon loss be readily detectable from a given tank. Positive indication of any amount less than this will also require immediate corrective action, namely, that of transferring the contents to a sound tank. Further work in the laboratory and field will be conducted to justify this method of calculation.

A review was made of chemical processing plant waste streams monitoring and sampling equipment. Several recommendations concerning the installation of additional or improved monitoring and sampling facilities were communicated to the Chemical Processing Department for possible inclusion in plant equipment budget forecasts.

Recommendations are being prepared for the disposal of high Co^{60} scavenged waste supernates (maximum Co^{60} concentration of 4×10^{-4} μc/cc) on a "use-test" basis at the 2l6-BC crib site. Present scavenging processes are unable to decontaminate TBP wastes of poorly-adsorbed Co^{60} to the present cribbable limit (4×10^{-5} μc/cc), but are able to attain concentrations slightly below 4×10^{-4} μc/cc. Satisfactory crib disposal of this waste requires that Co^{60} not enter the Columbia River in detectable concentrations, or in any concentration that will noticeably increase the fraction of the Off-Plant Limit in the river as a result of reactor effluent disposal.

[redacted]

Irradiation Processing Department

Disposal of Reactor Coolant Containing Phosphoric Acid

The temperature of the cooling water effluent is limited by the corrosion rates of the aluminum components of Hanford reactors. Considerable progress has been made in reducing the corrosion by chemical treatment of the cooling water; however, major improvement is not expected by further adjustments of pH, nor by changing the concentration of dichromate ion in the coolant. Laboratory corrosion data indicate that addition of phosphoric acid to the cooling water would reduce corrosion rates enough to permit higher exit water temperatures, which would mean higher power levels. The addition of this reagent increases the amount of radiophosphorus in the effluent through activation of P^{31}. Current effluent disposal of comparatively low phosphate coolant causes an increase in the river concentration of P^{32} that is of radiological consequence to fishermen consuming quantities of Columbia River game fish. These fish accumulate the isotope and the present level of contamination in their flesh is a matter of concern.

The amount of P^{32} found in the effluent is dependent upon three variables, the average neutron flux, the P^{31} concentration and the P^{31} exposure time. The flux can be considered a constant for Hanford reactors. The dependence of the residence or exposure time on the concentration is of interest. Water passing through a reactor has a residence time of about one second. Ewing's experiments of adding comparatively small amounts of phosphate to the cooling water indicate that the current average residence time for P^{31} is about 2.5 days, indicating retention on tube and slug surfaces, and subsequent release (1). The question of interest became: What would be the residence time for P^{31} in the 5 ppm phosphoric acid coolant proposed? To answer this question an experiment was conducted at 105-KE in which two process tubes were used. The control tube (5003KE) was operated under nearly current water conditions (exception, pH 6.0 instead of pH 7.0) and equivalent water used in tube 4903KE plus 5 ppm phosphoric acid. Effluent samples from each were analyzed for P^{32} and a few other radioisotopes. From these data the estimated residence time for P^{31} in 5 ppm phosphoric acid coolant averaged about 6 minutes. Of greater significance was that the addition of the phosphate increased the P^{32} concentration in the effluent by a factor of 20. Such an increase under our current operating conditions would not be tolerable. The application of this corrosion reducing method in a single full pile could not be allowed unless a radically improved effluent disposal method were to be developed. As far as can be determined, all plans to use phosphoric acid as a corrosion inhibitor in "oncethrough" reactors at Hanford have been abandoned.

[redacted]

There is, however, considerable interest in the possible use of phosphoric acid in a water recirculating reactor. An experiment was carried out in a single tube in-pile loop system at 105-H, in which Hanford type slugs were exposed to high temperature 5 ppm phosphoric acid coolant (pH 4.5). After twenty days the experiment was concluded and the total quantity of P^{32} accumulated in the system was found to be about 0.08 curies. The coolant was disposed via the normal 105-H effluent system over a period of one hour. The river concentration of the isotope could not have increased significantly from either the post-test disposal or from any loss of coolant during the test. More significant, the test failed to reveal any major disposal problems associated with the use of phosphoric acid in a recirculating system. More corrosion experiments of this type are planned for the new in-pile loop facilities at 105-KE.

Columbia River Studies

Disposal of reactor cooling water effluent makes the largest contribution to radioactive contamination of the Columbia River. Changes in the quantity of radioisotopes in the effluent have been noted with changes in reactor power level, in methods of cooling water treatment and in the seasonal variation of elements in the raw river water. Development of correlation between pile operating variables and effluent isotope concentration is needed to predict effects of planned production increases or other process changes and is needed to devise process control measures to reduce river contamination. Data collected from 1951 through 1955 have been processed by the IBM 702 computer and an attempt to derive the correlations has been made. These efforts have failed to show clear-cut correlations between individual isotopes and the independent variables. Further analysis of the data is scheduled.

III. LABORATORY EVALUATION OF WASTES

Laboratory soil column and batch (equilibrium) experiments were conducted for each tank of scavenged waste produced by the Uranium Recovery Plant. The concentrations of cobalt-60 in the scavenged waste and the disposal volumes, which were estimated on the basis of the adsorption of cesium-137 and strontium-90 by soil, are shown in Table 1

[redacted]

[redacted]

Table [illegible]. Concentration of Cobalt-60 and Estimated Disposal Volumes Based on the Adsorption Characteristics of Cesium-137 and Strontium-90

Waste Batch	Cobalt-60 uc/ml	Estimated Disposal Volumes: Cesium-137 Column Volumes	Estimated Disposal Volumes: Strontium-90 Column Volumes
45-110-BY	9.3×10^{-4}	1*	3
46-106-BY	2.8×10^{-4}	3	[illegible]
8-109-C	1.8×10^{-3}	3	<1
7-112-C	3.7×10^{-3}	<1	<1
47-107-BY	5.3×10^{-4}	1	3
48-108-BY	2.5×10^{-4}	3	[illegible]
49-110-BY	7.0×10^{-4}	3	3
50-107-BY	2.5×10^{-4}	1*	3

*Based on equilibrium data only.

The cobalt-60 determinations were made by the Analytical Control Operation. The remainder of the experimental work was performed by Chemical Effluents Technology Operation. The cobalt-60 radioisotope continued to be the limiting radioisotope in direct disposal to the ground except for wastes 7-112-C and 8-109-C, which were also limited by cesium-137 or strontium-90 or both. The breakthrough of strontium-90 in these two wastes was similar to the breakthrough observed in the past for farm scavenged TBP wastes containing aluminum.

IV. REGIONAL HYDROLOGY

Field data collected during a four-day aquifer test of the glacio-fluviatile sediments lying south of Gable Mountain were analyzed and gave a very high transmissibility value of 3,000,000 gpd/ft. Based on the derived aquifer coefficients, it is estimated that the discharge of 12 mgd of Purex cooling water to a proposed swamp south of Gable Mountain will result in a 7 ft. maximum rise of the water table after one year. The highest point on the water table will then be about 405 feet above mean sea level and there will then be a considerable north-to-south hydraulic gradient which will tend to route the contaminated ground water beneath 200-East Area to the south toward zones of rapidly south-eastward-moving ground waters.

Figure 3 is a map showing contours on the water table as of October 1956. The contours show that the aquifers underlying the project are [illegible] by natural inflow from high areas to the west and that the ground water moves in a general northeastward and eastward direction to the Columbia River. The most

[redacted]

prominent features are two ground-water mounds. One mound lies directly beneath the 200-West Area and rises to a maximum known elevation of more than 475 feet, and the other lies beneath the eastern edge of 200-East Area and rises to a maximum known elevation of more than 405 feet. The closer spacing of the contour lines defining the 200-West mound indicate an aquifer of lower permeability than that of the 200-East mound. The wide spacing of contours to the southeast of the 200 Areas suggests high permeabilities to the southeast.

When compared to the contour map of October 1955, Figure 4, the following significant changes are noted. (1) There has been a general shifting of specific contour lines eastward from the 200 Areas. In particular, the 395-foot contour has been displaced roughly 5 miles eastward, showing that the water table beneath 200-East Area has risen at least as much as 5 feet during the past year. (2) The 200-East mound has risen from a maximum known elevation of above 395 feet in October 1955 to over 405 feet in October 1956. The mound has also assumed a westward-trending hook at its southern extremity which will tend to restrain or retard the movement of contaminated ground water from beneath the 200-East Area to zones of high permeability to the southeast. (3) The 200-West mound has spread in all directions, but, more important, the peak of the mound has shifted from beneath the northwest corner of the area to beneath the southwest corner. Thus, whereas in October 1955 there was a preferred gradient of about 27 ft/mile to the southeast, there is now a preferred gradient of about 20 ft/mile to the northeast. A northeastward gradient tends to route contaminated ground water beneath the T-Plant second cycle crib toward the very permeable zone south of Gable Mountain.

Data from 70 dilution-velocity tests were examined and the resulting 200 velocity calculations were checked and evaluated. Fifty-three percent of the determinations were considered invalid for one or more reasons. Tests were considered invalid as a result of being conducted at an unsatisfactory depth with respect to the well casing perforations and in some instances as a result of non-linear log concentration-time functions. Test irregularities to which these non-linear functions may be attributed include (1) improperly or inadequately perforated casings, (2) plugged perforations, (3) imperfect mixing of electrolyte with well water, and (4) improper volume or concentration of electrolyte resulting in settling of the electrolyte. Laboratory model studies will be conducted to determine the effect and magnitude of these factors on the technique.

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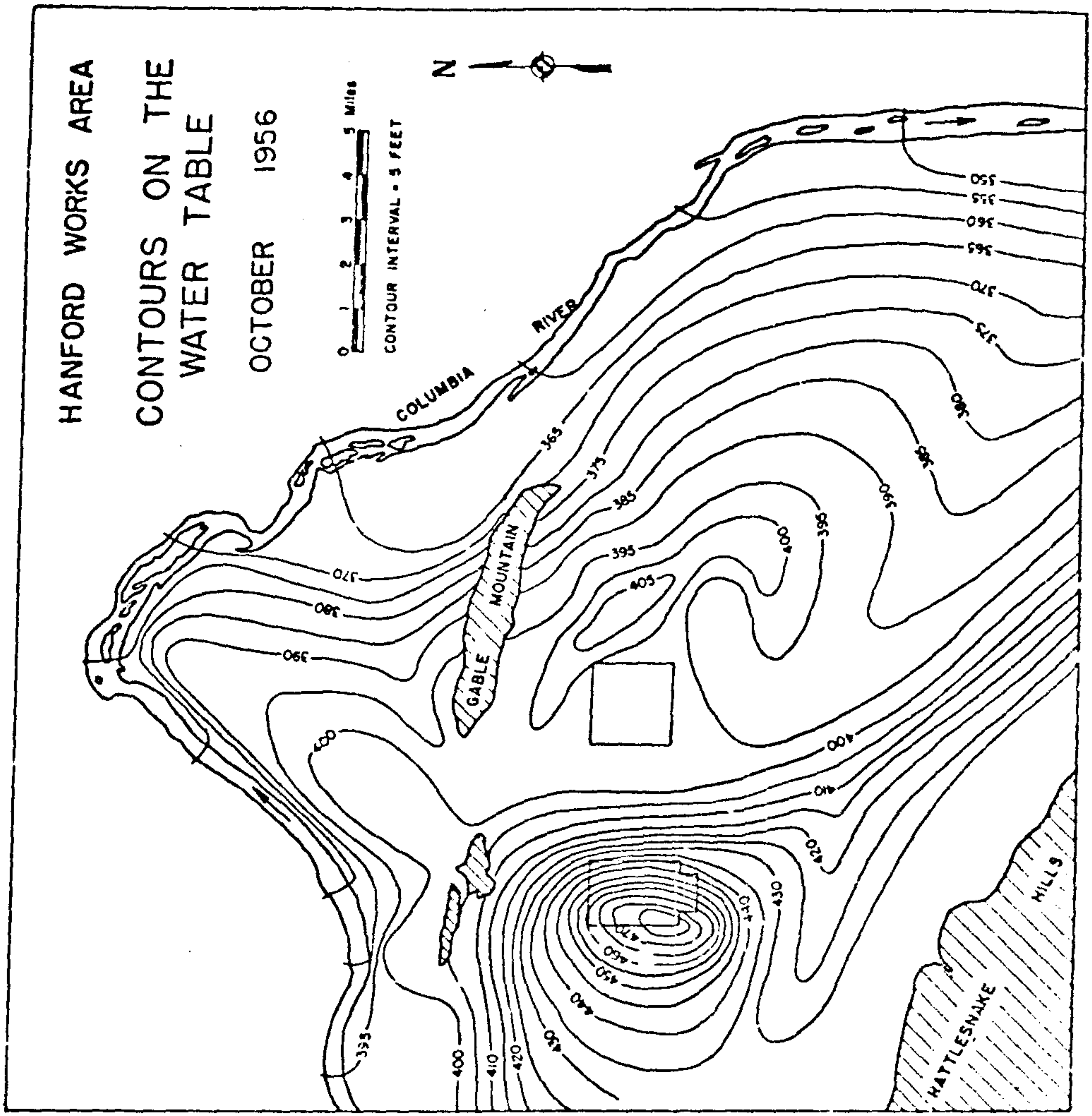
HANFORD WORKS AREA
CONTOURS ON THE WATER TABLE
OCTOBER 1956
0 1 2 3 4 5 Miles
CONTOUR INTERVAL = 5 FEET
N
COLUMBIA RIVER
GABLE MOUNTAIN
RATTLESNAKE HILLS

Figure 3.

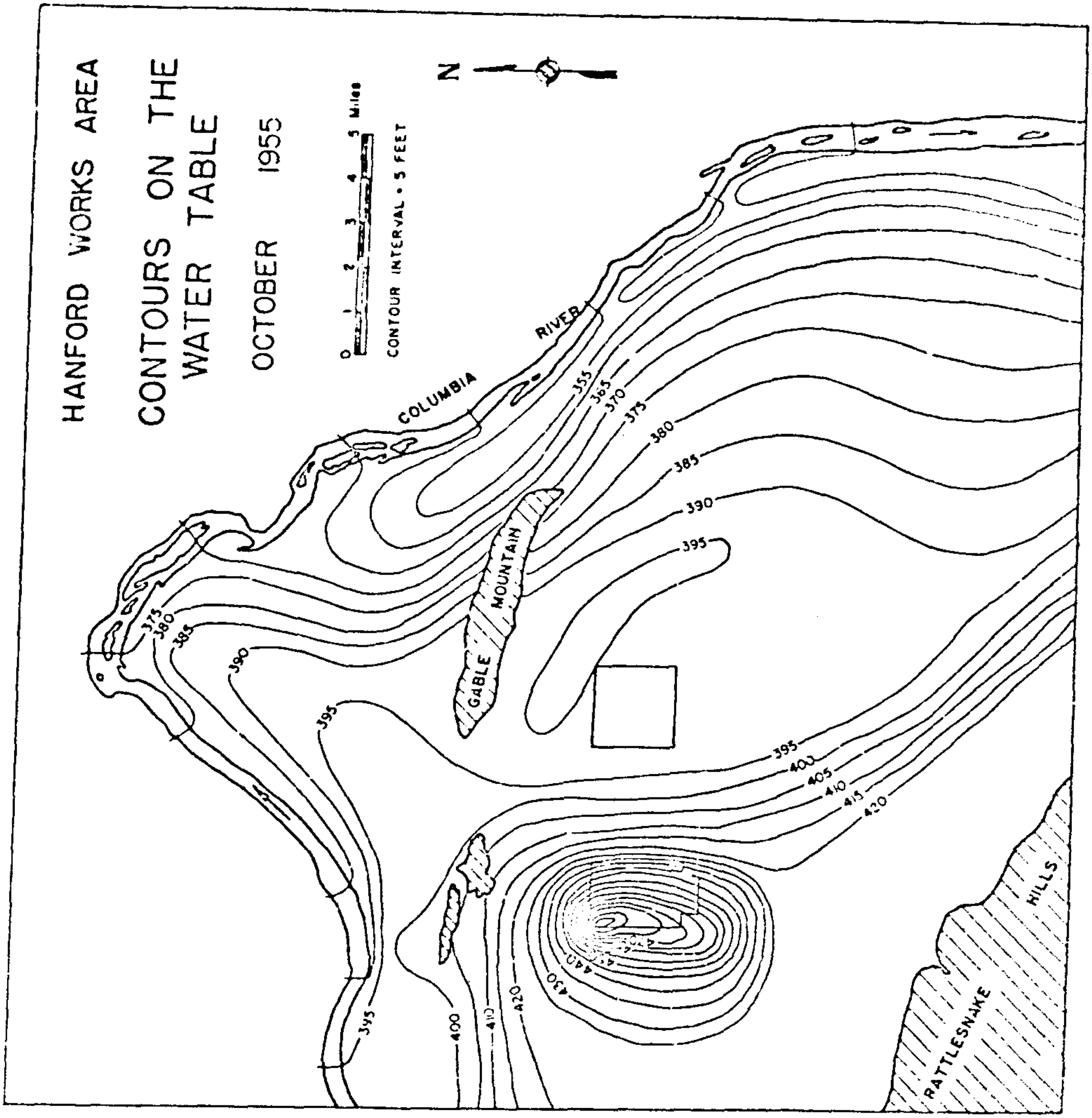
HANFORD WORKS AREA
CONTOURS ON THE WATER TABLE
OCTOBER 1955
0 1 2 3 4 5 Miles
CONTOUR INTERVAL • 5 FEET
N
COLUMBIA RIVER
GABLE MOUNTAIN
RATTLESNAKE HILLS
355
365
370
375
380
385
390
395
400
405
410
415
420
430
440

Figure 4.

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V. WELL DRILLING SUMMARY

TABLE

WELL DRILLING SUMMARY

Fourth Quarter 1956

U. S. G. S.

Well	Ft. Drilled	Finished	Total Feet	To Water?
699-51-63	185	11/ 5/56	185	Yes
299-E-24-7	450	11/28/56	450	"
299-E13-14	370	12/ 4/56	370	"
1199-22-16B	22	12/17/56	22	No
1199-22-16A	18	12/17/56	18	"
1199-22-16C	20	12/19/56	20	"
299-E13-15	364	12/28/56	364	Yes
	1,429			

Strasser Drilling Co.

Well	Ft. Drilled	Finished	Total Feet	To Water?
299-E13-12	364	10/10/56	364	Yes
299-E13-13	357	11/ 5/56	357	"
	721			

Wells Reperforated and Developed by U. S. G. S.

699-43-89	699-25-80	699-40-35	699-44-24
699-55-89	699-25-70	699-55-70	
699-34-89	699-50-30	699-45-20	

The U. S. G. S. drilling crews have completed 450 feet of drilling on the CA-700 Drilling Project, 734 feet on the CG-688 - PHASE III drilling contract, and 60 feet on an A. E. C. contract No. 1113 Modification 1-FP. In addition to this work they have reperforated and developed 10 wells in the vicinity of the 200-Areas.

The Strasser Drilling Co. has completed all of their current drilling contract on the Hanford Project.

[redacted]

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