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CHEMICAL EFFLUENTS TECHNOLOGY WASTE DISPOSAL INVESTIGATIONS

OCTOBER, NOVEMBER, DECEMBER, 1957

Prepared by Members of the

Chemical Effluents Technology Operation

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CHEMICAL RESEARCH AND DEVELOPMENT OPERATION
HANFORD LABORATORIES OPERATION

HANFORD ATOMIC PRODUCTS OPERATION
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PRELIMINARY REPORT

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CHEMICAL EFFLUENTS TECHNOLOGY WASTE DISPOSAL INVESTIGATIONS
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INTRODUCTION

The Chemical Effluents Technology Operation is assigned to investigate the chemical and physical 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 October-November-December, 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

Figure 1 shows the probable limits of ground-water contamination based on gross beta activity $> 1.5 \times 10^{-7}$ µc/cc in well water samples. Also shown are generalized contours on the water table as of June 1957. The general direction of ground-water movement is normal to the contour lines in the direction of the downward slope.

200-East Area

The principal, and potential, sources of ground-water contamination beneath 200-East Area are centered at three general disposal sites; (1) the 216-BY and 241-B cribs, (2) the 216-A cribs, and (3) the 216-BC cribs and trenches. The first listed sites last received wastes in December 1955. Nevertheless, wastes continue to percolate to the water table (depth to water about 240 feet below land surface), a maximum concentration of 8.0×10^{-2} µc/cc being reported for a ground-water sample from the site. The low-level contaminants reaching the water table beneath the B- and BY-sites move westward and southwestward down the hydraulic gradient imposed by the 200-East ground-water mound. (See "A", Figure 1). West of 200-East Area the water table occurs in permeable glacio-fluviatile sands and gravels, and contaminants reaching these sediments tend to move chiefly southward and somewhat southeastward. Extrapolating this movement to the future indicates a potential junction with the Columbia River near the 300-Area, but only after a significant lapse of time. The area "A" depicted in Figure 1 possibly merges with Area "D" as shown (see below).

The 216-A cribs receive Purex process wastes which infiltrate to the water table and result in the contaminated zone "B" shown in the figure. Three-fourths of the 7,900 curies discharged to these facilities has gone to the 216-A-8 crib which receives tank farm condensate and cooling water. Beneath

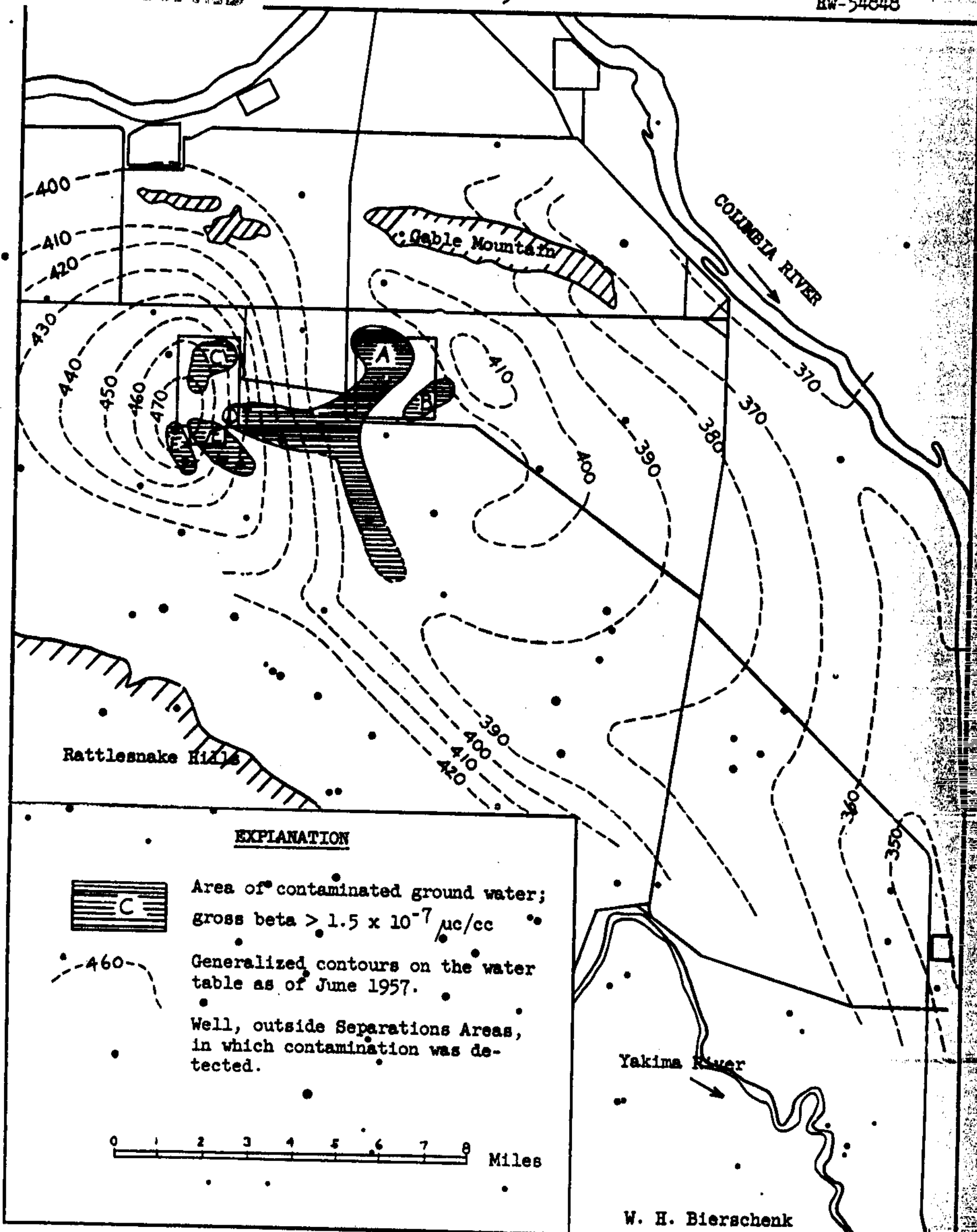

Fig. 1
Map showing probable extent of zones of ground-water contamination and contours on the water table.

this crib (depth to water about 275 ft) a maximum known gross beta concentration for the period was 3.1 x 10^{-3} μc/cc, reported 12-23-57. The contaminated ground-water is moving southwestward.

The 216-BC cribs and trenches receive TBP-Building and in-farm scavenged wastes. The December 1957 maximum average reported for gross beta concentration in the ground water (depth about 340 ft) was 1.2 x 10^{-7} μc/cc; below the contamination limit plotted.

Results from isotopic analyses made on well water samples from beneath the 216-BY cribs show Co^{60} in concentration exceeding the Radiation Protection Standards MPC of 4.0 x 10^{-4} μc/cc. As of 12-9-57 the water from one well analyzed 4.6 x 10^{-4}. This same well contained 1.3 x 10^{-3} μc/cc on 5-6-57 and has decreased in concentration ever since. Fission product analyses show no detectable concentration of Sr^{90} or Cs^{137} in test wells monitoring cribs within 200-East Area.

200-West Area

There are four zones of contaminated ground water beneath the 200-West Area. See Figure 1. The depth to water ranges from 200 to about 280 ft below land surface. Radioactive material from wastes have percolated down to the water table beneath the inactive T-Plant facilities resulting in zone "C" with a reported maximum gross beta concentration of 1.9 x 10^{-5} μc/cc on 12-3-57. The contaminated ground water moves northward and northeastward in accordance with the prevailing hydraulic gradient.

The second zone, "D", with a maximum known concentration of 7.8 x 10^{-5} μc/cc reported in October, lies beneath the 216-WR crib. As depicted in Figure 1, zone "D" merges with "A". This configuration is based on the lateral concentration gradient in three wells east of the area. Concentrations reported in December 1957 for these wells are respectively, 1.6 x 10^{-6}, 4.8 x 10^{-7}, and 2.5 x 10^{-7} μc/cc.

Zone "E" is contaminated by infiltrating wastes comprised of 241-SX tank farm condensate to the 216-SX-1 crib and by D-1 and D-2 wastes to the 216-S-7 crib. The maximum concentration reported duing the quarter was 2.6 x 10^{-3} μc/cc on 12-3-57. The contamination tends to move generally southeastward down gradient.

The fourth zone in 200-West Area, "F", lies beneath the 216-S-5 and 6 cribs which receive 202-S process vessel cooling water. On 12-10-57 the maximum concentration of 2.6 x 10^{-7} μc/cc was reported. This contamination can be expected to move south and southeastward.

Fission product analyses showed that water samples from one well monitoring the 216-S-1 and 2 cribs contained radioactive Sr^{90} in concentration of 8.8 x 10^{-7} on 10-30-57 and 6.5 x 10^{-7} $\mu c/cc$ on 12-10-57. No other wells in 200-West Area contained detectable concentration of either Sr^{90} or Cs^{137}.

II. PLANT WASTE DISPOSAL PRACTICE

CPD

Co^{60} Use Test

Eight batches of waste were processed through the in-farm scavenging operation this quarter. Although all of the scavenged supernatant liquid contained cribbable concentrations of Co^{60}, six batches demonstrated poor cesium adsorption characteristics, and one batch poor cesium and strontium removal. These seven batches were discharged to the 216-BC specific retention trenches. Batch 20, which fulfilled crib disposal criteria, was disposed of to the 216-BC-6 crib.

Coating Waste Disposal

Observation of the aluminosilicate gel in the "cold" test disposal pit east of the 300 Area has revealed that the volume occupied by the gel is now about 60% of the original volume. Practically all of this shrinkage occurred during the first month following disposal. The material near the surface of the pit still retains the gel-like appearance and consistency while the material near the bottom of the pit has become pasty in texture. Core samples obtained from the gel bed immediately following disposal showed a fairly uniform moisture content of 76% (wet basis). A gradual shift in the moisture distribution has been noted during the three months subsequent to the disposal. The moisture content of the gel at the bottom of the bed has varied only slightly from the original 76% while the moisture content of the gel near the surface has risen to 85%. The increase in moisture content near the surface was at first thought to be due to condensation of water vapors from the air; however, the gel surface temperature of 46° F rules out this possibility. Exploration of the soil under the gel bed, to determine the depth of moisture penetration, is planned for Spring 1958.

Preliminary laboratory investigations concerned with the drying of coating waste by mechanical methods indicate that drum-drying of gelled coating waste may have practical application as a disposal method. The objectionable feature of undried gel disposal is the subsequent loss of contaminated liquid from the gel to the soil. Partial or complete dehydration of the gel prior

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to disposal should eliminate this undesirable characteristic. A small drum dryer was constructed and will be operated to evaluate the feasibility of this disposal method.

High-level Waste Studies

A proposed procedure for a laboratory-scale test to demonstrate and obtain data on the self-sintering of gelled Purex high-salt and coating waste was prepared. Utilization of heat generated by radioactive decay of fission products to achieve self-sintering temperatures in wastes contained in a gel matrix may have potential as an ultimate disposal method. Preliminary investigations will be conducted to determine proportions of the various solutions which when combined will produce a satisfactory gel.

IPD

Decontamination of Reactor Piping

The waste disposal aspects of cleaning the rear face piping at 105-H with Turco 4306-B were evaluated. The purposes of the cleaning experiment were to determine if this reagent could be used for improving contamination and exposure rate conditions in reactor discharge areas and to investigate possible problems arising from the disposal of the spent cleaning solution. Analytical results, of the reactor effluent water and the river water, led to the conclusion that the cleaning operation caused no major pollution problem. The slightly higher than normal concentrations of Fe^{59}, Zn^{65}, and Np^{239} in the F Area's water supply indicate that radioactive contamination of drinking water, of reactor areas downstream, of the cleaning operation, is potentially the most serious of the disposal aspects investigated. It was recommended that future tests of this cleaning method should provide for as slow a release of waste to the river as is practical. Also, since the first cleaning test did not provide enough data to permit the formulating of routine disposal specifications of the spent solution, it was recommended that future tests be supported by disposal evaluation programs.

Document HW-53372 "Disposal of Decontaminating Agents for Reactor Rear Face Piping" (1), was issued.

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As^{76} In Reactor Effluents

Plans and arrangements were made to determine the influence of seasonable operating variables on the rate reactors release As^{76} to the river. Previous work indicates that As^{75} in the process water is the source of all As^{76} in the reactor effluent. The operation of 105-B will be studied and all samples will be taken at that location. River water and process water will be analyzed for As^{75} by emission spectrometry methods. Samples of additives used in treating the water will also be analyzed. The sampling, collecting of operational data, and analytical work will start in January and will probably continue for about one year. As^{76} is of particular interest because it contributes about one-half of the gastro-intestinal tract irradiation sustained by individuals drinking Columbia River water downstream from the reactors. This study may lead to ways and means of reducing the release rate of As^{76} without limiting reactor production.

Coolant Effluent Disposal Facilities

The progressive deterioration of concrete retention basins, particularly at B, D, and F Areas, makes the repair or modification of these basins necessary within five years. IPD submitted four proposals for altering the coolant disposal facilities of which the proposal for a direct line from the reactor to the river outfall appeared to be the most feasible. This essentially eliminates the release of contamination along the river shore, and consequently it was recommended that this proposal be made the subject of a FY-1960 construction budget study. A recommendation was also made to use the present basin and cribs as a bypass system to accommodate off-standard effluents (rupture and purge effluents in particular). The nearly empty basins would have over two hours of effluent capacity and after a settling period the off-standard contents would be sent to the crib.

FPD

Uranium Oxidation and Fission Product Volatilization Experiments

Preparations continued for the high temperature uranium oxidation and fission product volatilization experiments. All equipment was received except for the furnaces. The Burrell resistance furnace was rescheduled for January delivery. The high frequency converter for induction heating will probably be received in the second quarter of 1958.

Two hundred natural uranium specimens were prepared for the tests. They measure 1/8-inch in diameter by 1-inch long and weigh 4 grams each. They were all produced from the same reactor slug so that their metallurgical history should be identical.

A quartz wool filter was designed to trap particulate material from the hot furnace exhaust stream. Testing showed that at room temperature, retention of 99% of 2 - 5 micron particles from a ZnS-Talcum powder mixture was realized. This was determined by examining a millipore backup filter microscopically under ultra-violet light. No tests were made at higher temperatures.

III. LABORATORY EVALUATION OF WASTES

The disposal program for scavenged waste was essentially completed as scheduled. Only two batches of waste remain to be tested. Samples of eight batches of uranium recovery waste were tested by standard soil column procedures and in each case the Co^{60} concentration was below 4×10^{-4} µc/cc. However, none of the eight scavenged solutions passed as much as one column volume through a laboratory test column before a Cs^{137} and/or a Sr^{90} break-through was observed. Crib disposal was, therefore, not recommended for any of this waste. Table 1 summarizes these results.

TABLE 1

SUMMARY OF LABORATORY COLUMN TESTS FOR Cs^{137} AND Sr^{90}

Date Test Started	Waste Batch Number	Measured Volume (Breakthrough) In Column Volumes	
		Cs^{137}	Sr^{90}
10-18-57	20-112 C	< 1	< 1
10-18-57	21-108 C	< 1	< 1
10-18-57	22-111 C	< 1	< 1
10-25-57	23-109 C -107 B	< 1	< 1
11-20-57	24-112 C	< 1	> 3
11-22-57	25-108 C	< 1	> 4
12-20-57	26-111 C	< 1	> 4
12-20-57	27-109 C	< 1	< 1

The program to appraise capacity of ground-waste disposal facilities was continued by initiating multiple laboratory soil column tests with Purex process condensate wastes. Similar tests were started on the Redox D-2 waste, which is discharged to the 216-S-7 crib. Column testing was continued on Purex A-8 waste. Calculations based on the last data resulted in capacity estimates for the 216-A-8 crib of as much as 27 column volumes. Compared with 9 column volumes estimated from previous data, this variation may be attributed to inaccuracy of analytical data at extremely low concentrations, variations in flow velocity through the column, and the fluctuation of other variables to which the calculations are sensitive. Recent

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research results from this laboratory indicate that temperature may have an appreciable effect on the rate of ion uptake by the soil. Consequently some of the laboratory columns are being run at the temperature of the process condensates, the others as usual are being run at ambient laboratory temperature. A brief study of the component streams of Purex A-5 waste, H-4, J-8, K-4, and F-5 indicated that the limestone bed through which these streams pass before discharge to the crib had no appreciable effect in reducing the radioisotope concentration. A special column to simulate the Redox 216-S-7 crib is being run with an abnormally high-level D-2 sample in addition to the normal waste. During an equipment cleanout, 100,000 gallons of this "hot" waste was generated. A calculation of its effect on crib capacity will be made.

IV. GROUND-WATER HYDROLOGY

Water-level and water temperature data indicate that Rattlesnake Springs and the "Benson Ranch" well water represent unconfined water in an aquifer which is separated from those underlying the Separations Areas. The buried extension of Yakima Ridge forms a ground-water dam which prevents direct ground-water recharge from Rattlesnake Hills northeastward toward Gable Mountain. Similarly, the dam impedes the southward expansion of the 200-West ground-water mound, thus prolonging the time required for stabilizing this mound.

Two additional values for aquifer transmissibility were obtained. A coefficient of transmissibility of 70,000 gpd/ft was estimated from well-performance data for a U. S. Army well on Wahluke Slope. This gives a coefficient of permeability for the Ringold conglomerate of 350 gpd/ft^2. Previous permeability values obtained for this aquifer ranged from 150-400 gpd/ft^2 (2), suggesting that the small range of values will permit a fairly reliable estimate of permeability to be applied wherever the aquifer is identified.

The second transmissibility value was estimated from data obtained subsequent to the discharge of Purex process water to the new Gable Mountain swamp north of 200-East Area. The transmissibility value of 2,600,000 gpd/ft is based on the rate of rise of water level in a well 4,000 ft from the effluent pipe outfall, and agrees closely with the value of 3,000,000 gpd/ft obtained from a multiple-well aquifer test in this area. It thus appears that it will be possible to predict with confidence the future rise of water levels due to recharge from the new swamp. Interpolation of graphical data presented in HW-48916 shows that if 2,000 gpm (approximately the current rate) is discharged to the Gable Mountain swamp, after 1 year the water level beneath the outfall will rise about 1.6 ft and at the 4,000 ft well it will rise about 0.2 ft. Consequently, no significant changes in direction or rate of ground-water movement are expected in this area.

Data received from Methods Development Operation gives tritium to hydrogen ratios for water samples from 2 wells and 10 surface sources. The surface water samples averaged about 5×10^{-17}, ranging from 3.3×10^{-17} to 8.3×10^{-17}. The well water samples gave 1.1×10^{-16} and 2.3×10^{-16}. Because of the greater values for the presumed "older" well water, the data do not encourage the use of such tritium analyses for dating Hanford ground waters and for estimating rates of movement.

Document HW-51277 (3), depicting changes in the Hanford water table between 1944 and June 1957, shows that with artificial recharge of 29.4 billion gallons of process water from chemical processing plants to underlying aquifers, two separate and distinct ground-water mounds have formed. Through the years the eastern mound has risen a known maximum of about 25 ft and the western mound about 90 ft. The size and shape of these mounds have fluctuated, depending upon the locations of disposal sites and the rates and total volumes of waste water disposed.

Document HW-53599 (4) includes long-term hydrographs of water levels in 44 wells at Hanford. It is shown that water-table fluctuations are controlled primarily by the artificial recharge of aquifers by infiltrating liquid effluents, although locally some natural fluctuation is caused by alternate seepage into and from the Columbia River. In addition, the observed water level in certain wells may fluctuate due to changes in atmospheric pressure or due to earthquake shocks. Between 1944 and 1957 an estimated 4 billion cubic feet of plant effluents have saturated approximately 62 billion cubic feet of sediments. The average wetted porosity of the affected sediments is thus calculated to be about 6.4 percent. This newly-saturated zone presumably contains essentially all the infiltered waste water.

V. WELL DRILLING SUMMARY

TABLE 2

WELL DRILLING SUMMARY

Fourth Quarter 1957

U.S.G.S.

Well	Ft. Drilled	Finished	Total Feet	To Water?
699-51-75	347	10-3-57	382	Yes
699-50-84	600	11-21-57	600	" "
299-E13-5	0	12-4-57	367	" "
	967		1349	

Hatch Drilling Co.

Well	Ft. Drilled	Finished	Total Feet	To Water?
299-E28-9	156	10-8-57	350	Yes
299-E19-1	370	12-11-57	370	" "
699-17-93	31	10-4-57	31	No
699-20-87	388	11-2-57	388	Yes
699-43-104	464	11-4-57	464	" "
699-43-11	350	12-12-57	350	" "
	1759		1953	

Drilling crews of the U.S.G.S. completed two wells on the CA-700 drilling contract. The total footage drilled on this contract to date is approximately 5,623 feet. The number of wells completed is 14. This completes the portion of the CA-700 drilling contract assigned to the U.S.G.S.

In November 1957, the A.E.C. requested the U.S.G.S. to deepen well 299-E13-5 as specified in the CG-764 drilling contract. This is an 8-inch well, 367 feet deep, located adjacent to the 216-BC-5 crib. However, early in this operation it was discovered that the casing near the bottom of the well was too far out of alignment to permit passage of a 6-inch casing, consequently the operation had to be abandoned.

The Hatch Drilling Company has completed 20 wells on the CA-700 drilling contract. These wells represent a total footage of approximately 6,000 feet. They now have three wells remaining to complete the contract.

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