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CHEMICAL EFFLUENTS TECHNOLOGY WASTE DISPOSAL INVESTIGATIONS

JANUARY, FEBRUARY, MARCH, 1957

Prepared by Members of the

Chemical Effluents Technology Operation

Edited by: D. J. Brown

June 26, 1957

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HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

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CHEMICAL EFFLUENTS TECHNOLOGY WASTE DISPOSAL INVESTIGATIONS

JANUARY, FEBRUARY, MARCH, 1957

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CHEMICAL EFFLUENTS TECHNOLOGY WASTE DISPOSAL INVESTIGATIONS JANUARY, FEBRUARY, MARCH, 1957

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 January, February, and March, 1957.

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

Data collected from wells in the vicinity of 200-East Area indicate that the rate of build-up of the Purex ground-water mound is diminishing. This reduction in the rate of build-up is probably the result of equilibrium conditions being approached between the volume of nonradioactive cooling water going to the Purex swamp and the transmission capacity of the surrounding aquifer. During the first quarter of 1957 the Purex ground-water mound showed an increase of 0.5 feet as compared to 2.4 feet for the fourth quarter 1956 and 5.7 feet for the third quarter 1956. With an increase of only 0.5 feet in the elevation of the Purex ground-water mound no significant change would be expected in the pronounced westward ground-water gradient under the 200-East disposal sites. This gradient continues to move the contaminated ground water to the west where it spreads to the north and south. (See Figure 1). In the north the contamination appears to be moving around the western edge of a natural basalt barrier located north of 200-East Area. Analyses of samples from some wells north of Gable Mountain and as far east as the Hanford town site indicate a radioactive material content above the natural average background concentration, which may indicate some contamination from the 200-East area moving around the western end of Gable Mountain. South of the 200-East area contamination appears to be moving southward as far as Goose Egg Hill where it probably is diverted southeastward by an underground basalt ridge.

Radioactive material from wastes discharged to the 216-A-8 crib have reached the ground water in concentrations as high as 1×10^{-2} $\mu c/cc$. This represents a concentration increase of 10^5 times the previous quarter's average. No breakthrough of long-lived isotopes into the ground water beneath this crib has been observed.

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

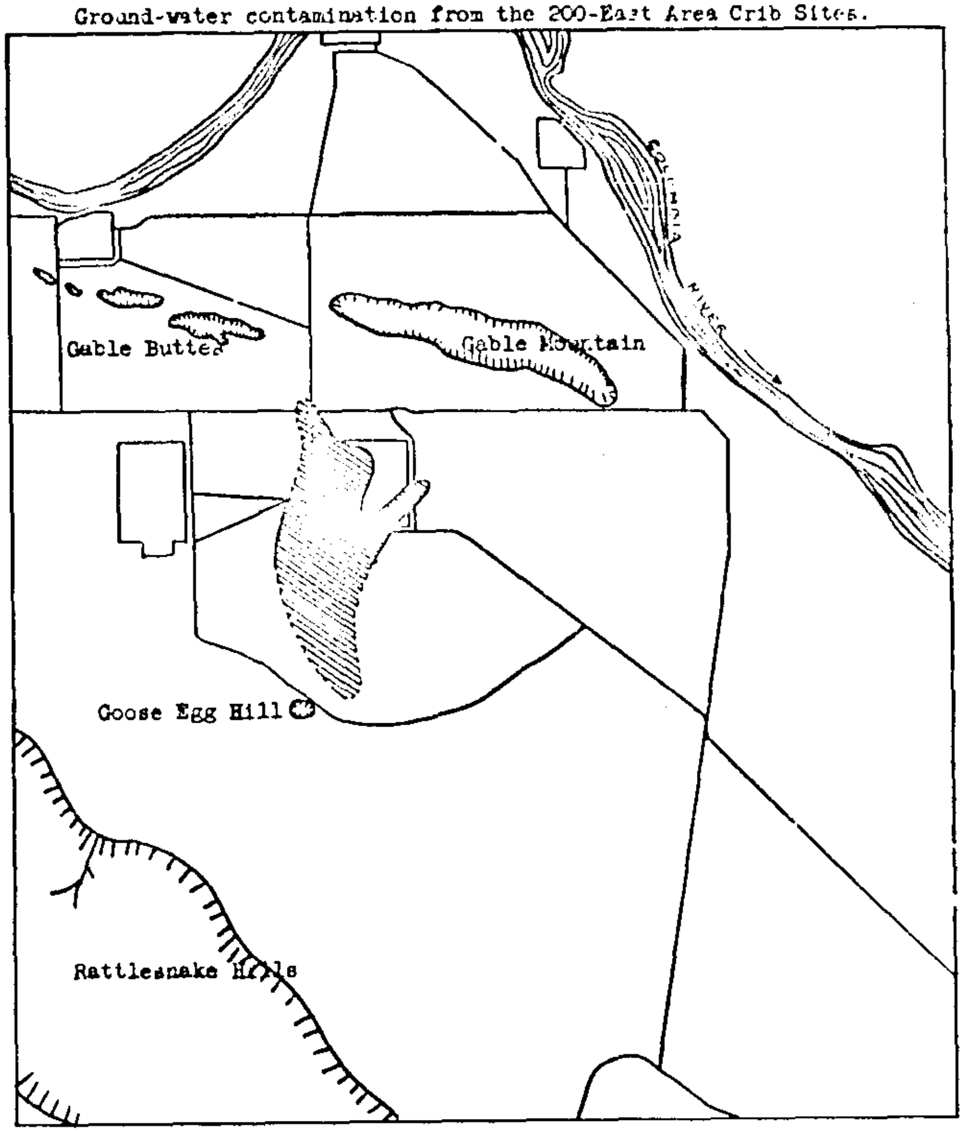

Figure 1.

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

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Vertical Distribution of Contamination in the Ground Water

An investigation was started in 1956 to study the effects of geologic structure and waste density on the vertical distribution of contamination in the ground water. Since it had been previously observed that the surface level of the ground water frequently displays a higher velocity than other levels, it was anticipated that contamination would first appear in the upper horizon of monitoring wells. This effect was verified by depth-sampling tests conducted in monitoring wells southeast of the 200-East Area (HW-49465). It was recognized, however, that "settling" of high salt wastes and the influence of the different permeabilities of various geologic strata comprising the local aquifer could also influence the vertical distribution of contamination. To test these influences a series of depth samples were obtained from a well 2500 feet south of the BY disposal site in the 200-East Area.

The drilling log of the test well was qualitatively examined for permeability differences within the 35-foot zone of the ground water which it penetrated. The bottom of the well is approximately 15 feet above the basalt bedrock. The lower 20 feet of the saturated zone appears to be relatively uniform in composition and should have a uniform permeability, while the upper 15 feet is of finer material with a corresponding lower permeability. It was therefore anticipated that contamination would appear first within the lower 20 feet of the well.

A delayed-action depth sampling device, which collects undisturbed water samples from different depths simultaneously, was used for this investigation. Analyses of samples collected during the first quarter of 1957 showed contamination first appearing within the lower 20-foot zone as predicted. Later sampling revealed a striking variation of concentration within the uniform lower 20-foot zone as contamination continued to move into the vicinity. The contamination appeared to be stratified with the highest concentration near the bottom of the zone. The concentration varied from 3×10^{-7} $\mu c/cc$ near the top of this 20-foot horizon to 7×10^{-4} $\mu c/cc$ near the bottom. At the same time no contamination could be detected in the surface levels of the water in the well.

This phenomenon may be caused by the variation in the permeability of the geologic formations in this area, but appears more probably to be caused by sinking of high density waste solutions. This conclusion is based on the pronounced stratification observed in the lower zone of apparent uniform material. Investigations of vertical contamination stratification are being continued.

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200-West Area

Results from test wells monitoring the ground water in the vicinity of 200-West Area indicate no significant change in the ground-water contamination pattern during the past quarter. Figure 2 illustrates the approximate extent of ground-water contamination from cribs located within the 200-West Area. The relatively slow movement evident from comparison with the chart in HW-50186, Chemical Effluents Technology Waste Disposal Investigations - October, November, December, 1956, is primarily attributed to the fine grained sediments which have relatively low permeabilities. Average ground-water velocities in material of this kind would result in movement of between 180 and 360 feet in a three-month period.

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Ground-water contamination from the 200-West Area crib sites.

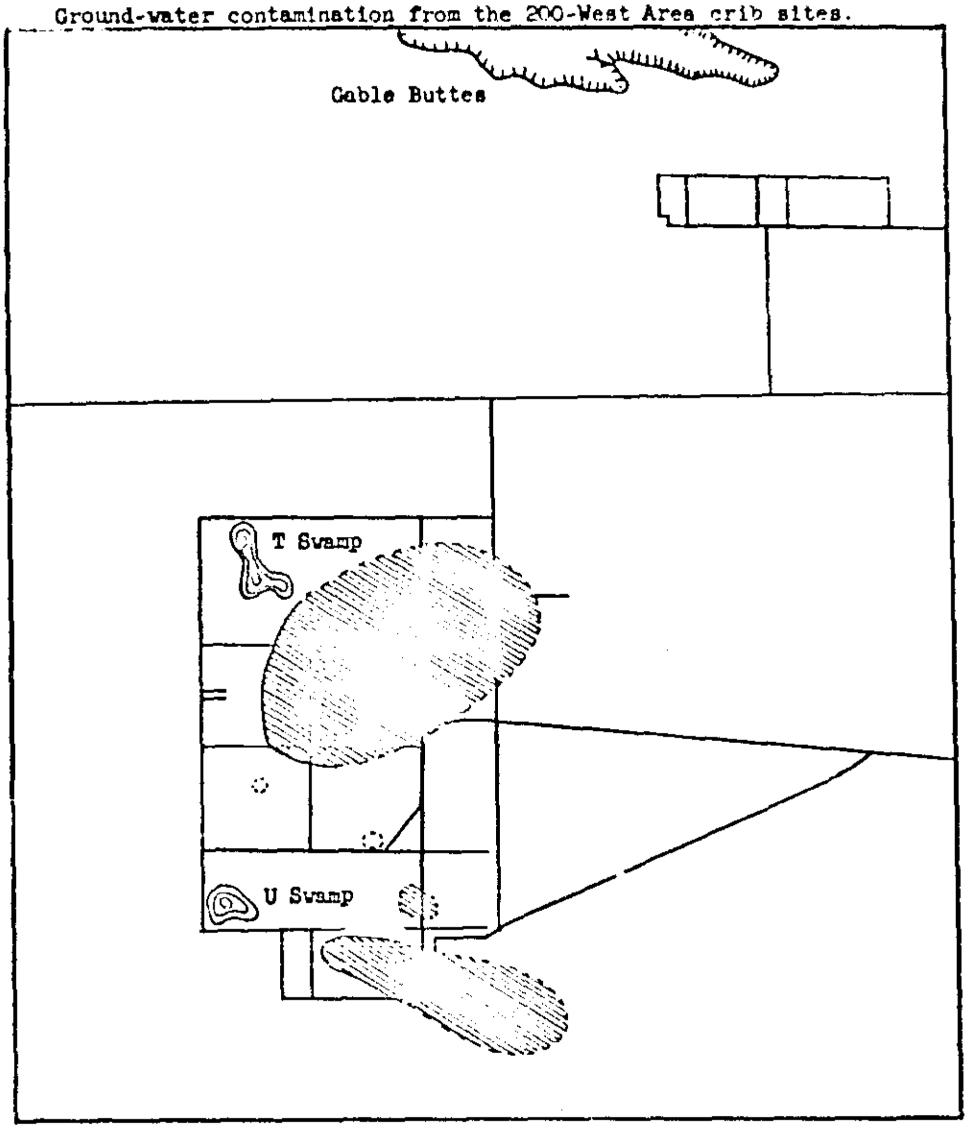

Figure 2.

Contamination pattern as of March 1957 as depicted by outlining the 1.5×10^{-7} $\mu c/cc$ ground-water contamination limits.

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II. PLANT WASTE DISPOSAL PRACTICE

Chemical Processing Department

A hazards study was prepared at the request of the Chemical Processing Department evaluating the effects on the environs from release of 50,000 pounds per hour of uncondensed vapors from the Purex Tank Stack and 3,000,000 gallons of high activity stored waste. Results of the study indicate that respiratory protection would be required within a distance of 100 meters downwind of the stack, and appreciable beta radiation dose rates would be encountered, resulting from fall-out of entrained activity, within 50 meters of the stack. Loss of 3,000,000 gallons of stored waste through tank failure would very probably result in radioactive isotopes entering the regional ground-water table in concentrations greatly exceeding existing limits.

A program to demonstrate field disposal of coating removal waste as an aluminosilicate gel has been developed. Laboratory investigations have demonstrated the feasibility of forming the gel by reacting five volumes of waste with two volumes of a 20% Na_2O + 3.3 SiO_2 solution. The field disposal program will first be demonstrated on a "cold" basis employing synthetic waste. Major items of investigation will be concerned with: Mechanics of the disposal, effects of leaching agents, moisture and radioactivity loss to the soil, and aging effects.

Document HW-48862, "Disposal of High Cobalt-60 Scavenged Wastes", March 4, 1957, recommends normal crib disposal on a test basis of scavenged wastes having a Co^{60} concentration below 4×10^{-4} $\mu c/cc$ (previously recommended cribbable limit was 4×10^{-5} μc Co^{60}/cc) and demonstrating satisfactory strontium and cesium soil adsorption. The 216-BC cribs were recommended as the disposal facility. It is expected that the test disposal will yield data on dilution and dispersion of high salt wastes in ground water that will be useful in establishing future waste disposal policites.

300 Area Waste Disposal

Sampling traverses of the Columbia River immediately above and below the 300 Area were performed by Regional Monitoring Operations at the request of Process Demonstration and Analysis. Uranium analyses of the samples should provide concrete data for revaluation of 300 Area waste disposal policy, and valuable data on shoreline discharge dilution that may have application in formulating future 100 and 200 Areas waste disposal policies.

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Irradiation Processing Department

Columbia River Studies

The statistical study continued of relations between concentrations of radioactive isotopes in reactor effluent water and reactor operating variables. Data collected between 1951 and 1955 processed on the 702 computer were further examined to determine significant correlations. Although the results of this study were less fruitful than anticipated, in that they failed to show clear-cut correlations, certain degrees of relationship were established. One variable of significance appears to be the flow rate of coolant through the reactor. It was clearly established that as the flow rate increased the concentrations per unit power level decreased for each of the effluent isotopes checked. This fact would be useful, for example, in predicting the effect of increasing coolant flow as in the CG-558 program. However, when the relationship was examined between concentration of isotopes and outlet water temperature, which is assumed to be one of the more important variables, only a slightly significant correlation was found. The ability to make predictions of concentrations from a knowledge of reactor variables was further complicated by the apparent strong effect of changing water treatment methods such as the use of different flocculants, corrosion inhibitors, pH adjustments, etc. It is believed that insufficient effluent analytical data for any given water treatment method was largely responsible for inadequate development of correlations between other variables. Experience was gained in the handling of these data and it is expected that further statistical treatment of reactor data will result in a better conception of the influence each of the operating variables have on the concentration of isotopes in the effluent. There appears to be little prospect that any major breakthrough in this field can be accomplished rapidly by a short term program. A report is planned that will summarize the findings to date and propose continuation of the program using similar methods.

The use of Turco 4306-B has been proposed as a decontaminating agent for internal cleaning of reactor rear face piping. The prime object of the decontamination would be to reduce discharge area personnel exposure rates. The reagent would be used in concentrations of about one ounce per gallon. Decontamination would be carried out during a reactor outage when the coolant flow has been reduced to the normal shutdown rate. The original proposal was similar to a diatomaceous earth purge in that the reagent would be prepared in the valve pit purge tank and added through the cooling water piping. The flow would be through the process tubes, into the rear face piping and to the river via the normal effluent system including the 107 retention basins. An alternate method has also been proposed whereby the reagent would be injected into a rear face riser which would eliminate the need for having any Turco solution entering the process tubes. The flow of reagent under this proposal would be through the rear crossheaders and pigtails counter-current

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to normal, and discharged from the nozzles through loosened caps into the storage basin. It would pass from there into the normal effluent system to the river via the 1608 pumps. Investigation of disposal problems related to both proposals has been started. Toxicological effects resulting from the discharge of the reagent into the river as well as physical and chemical effects on downstream water treatment processes are being reviewed. An investigation is also being made of the significance of additional river contamination resulting from the release of radioisotopes from process tubes, discharge area piping, storage basins, and retention basins. As an example, an attempt is being made to determine how much more contamination can be expected to be extracted from retention basin sludge by the Turco solution than by the normal reactor effluent. This experiment is in progress at quarter end.

Automatic Analyzing Monitor For Reactor Effluent

The development continued of an instrument to sample reactor effluent water and analyze the sample for several predominant isotopes. Mechanical features of the monitor which include the basic structure, cup storage and handling provisions, were completed. The electrical components including cup actuation, programming, and safety circuits are well along, although some untested features must be perfected. Considerable difficulty has been experienced in cleanly removing isotopes which interfere with the measurement of P^{32}. Predominant contamination is from As^{76}, with W^{187} and I^{133} also appearing in the sample. Improved clean-up was experienced when tungstic acid and cinchonine were used following the CuS bed, and when nitric acid was used to replace hydrochloric in the column feed preparation. Electronic instruments required were assembled and are being tested. These include the scaler, count rate meter, recorder, analog-to-digital read-out, the gamma ray spectrometer instrumentation required, and the data printer. During the period a 100-channel analyzer was received to assist in the study of problems relating to reactor effluent monitoring.

Slug Rupture Detector Study

An investigation was reactivated to determine the ability of presently installed slug rupture monitors to yield quantitative fission product concentrations. The design basis of the present instrument was that a significant signal would result when a very small fission product release occurred. Its use as an index to the approach of an intolerable concentration of fission product from a radiological hazard standpoint, although not anticipated in the original design, may be developed as a supplemental use of the instrument if it could be calibrated. An earlier preliminary study indicated that there apparently existed no fixed relation between fission product concentration and signal during a rupture. Recent calculations indicate that 10% of full scale response should correspond roughly to about 10% of the working limit of fission product permitted in reactor effluent. At the present time the instruments are not being used, calibrated, and maintained in a uniform, consistent manner, hence some delay in the accumulation of reliable rupture data is expected.

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Estimates were made of fission product isotopes entering the Columbia River from ruptures during 1956 and compared with those entering during 1952. A significant increase was noted. Increase in rupture severity rather than frequency was indicated to account for the increase. Although isotopes entering the Columbia River from ruptures comprise only a fraction of the total present, significant increase is cause for concern, since adsorption and retention by aquatic life and bottom gravels are presently poorly defined.

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III. LABORATORY EVALUATION OF WASTES

Soil column and equilibrium experiments were conducted in the laboratory with three batches of waste from the Uranium Recovery Plant. The disposal volumes, which were based on the adsorption by soil of cesium-137 and strontium-90, and the concentrations of cobalt-60 in the waste, are shown in Table 1.

Table 1. Estimated Disposal Volumes Based on The Adsorption By Soil of Cesium-137 and Strontium-90.

Waste (Batch No.)	Cobalt-60 ($\mu c/ml$)	Cesium-137 (Column Volumes	Strontium-90 (Column Volumes)
51-107-BY	4.1×10^{-4}	≤ 1	>3
52-108-BY	2.9×10^{-4}	> 3	>3
53-110-BY	7.2×10^{-4}	>3	1

A rapidly increasing breakthrough of strontium-90 between 1 and 2 column volumes for waste 53-110-BY suggested the presence of interfering substances, possibly aluminum. A similar effect was observed for certain farm scavenged wastes, which were tested earlier. The data for cesium-137 in waste 51-107-BY indicated approximately 1 column volume as a disposal volume, however the borderline nature of the results required that the disposal volume be restricted to something less than one column volume.

A laboratory soil column test was run with a sample of A-8 waste (condensate from A-Farm) and the results indicated that strontium-90 very likely would be the limiting radioisotope in this waste. The ratio of the concentration of strontium-90 in aliquots of the soil column effluent to the concentration of strontium-90 in the influent were plotted against volume of effluent expressed as column volumes. The resulting straight line is shown in Figure 3 with the data extrapolated to the limiting concentration of, $C/C_0 = 8 \times 10^{-8}/1.6 \times 10^{-5} = 5 \times 10^{-3}$. The volume corresponding to this limiting breakthrough concentration is approximately 13.5 column volumes. Future operating plans indicate that an increase in the activity density of the condensate waste will occur. For this reason, the capacity of the A-8 crib can be expected to decrease more rapidly than would be predicted from the preceding experimental data, and additional experimental work will be required to evaluate the effect of this increase in activity density.

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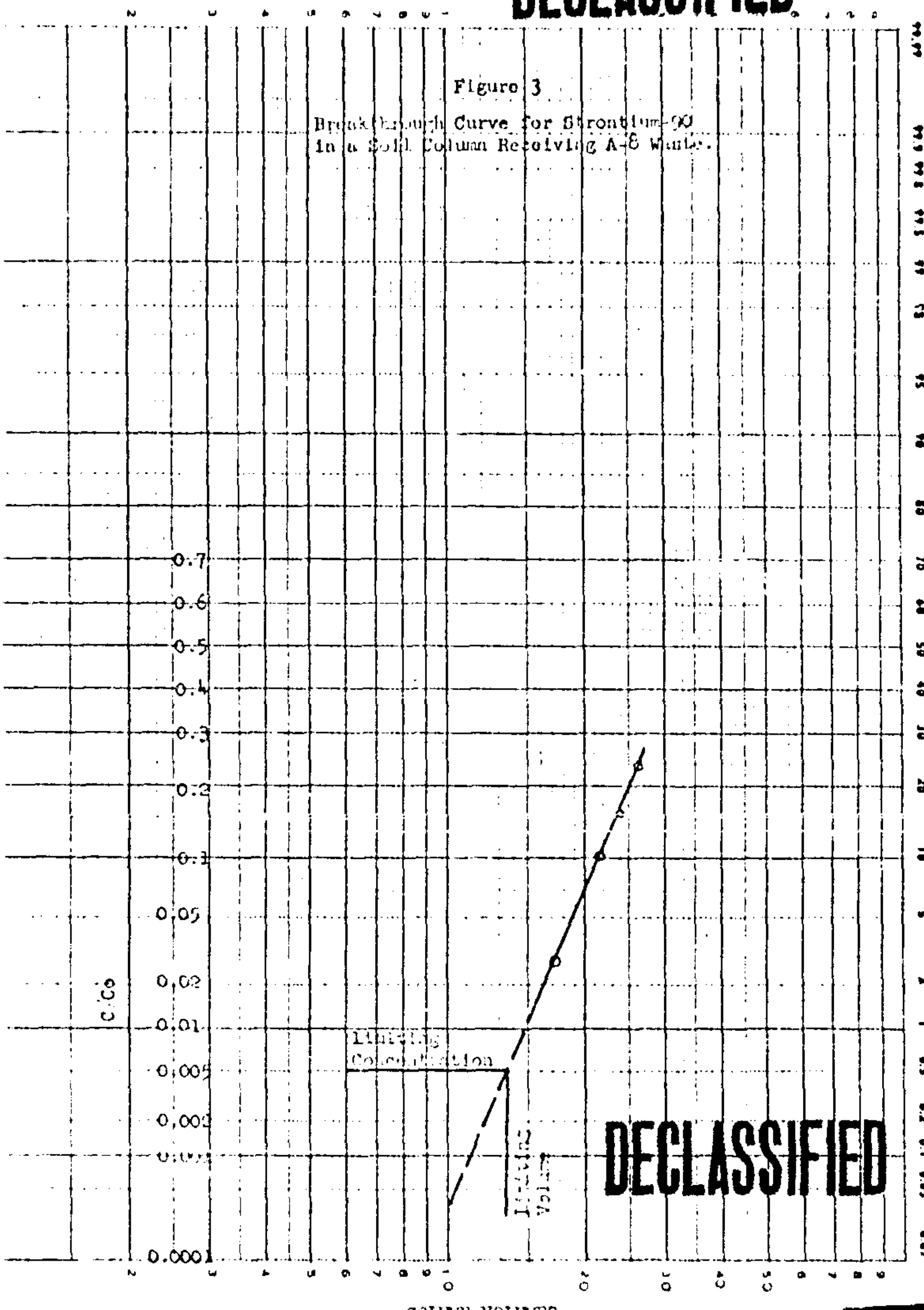

Figure 3

Breakthrough Curve for Strontium-90 in a Soil Column Receiving A-8 Waste.

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IV. REGIONAL HYDROLOGY

The size and shape of the ground-water mounds beneath the 200-East and 200-West Areas fluctuate in direct response to the volumes of waste liquids disposed to ground and according to geologic controls. During 1956, the first year of Purex operation, the 200-East mound rose a total of about 13 ft. as a result of an average disposal rate of 6.5 mgd. The present rate of disposal is about 7 mgd. Combining this rate of recharge of water to the aquifer with roughly estimated values for the hydraulic characteristics of the aquifer permits the prediction that during 1957 the 200-East mound will rise no more than an additional foot, or to an altitude of approximately 412 ft. Thus, during the year, no substantial changes in the present rates and directions of ground-water movement from the 200-East Area are expected unless the disposal rate is greatly increased.

Continuing changes in disposal rates in the 200-West Area preclude a quantitative estimate of the mound during 1957. However, a qualitative estimate may be made on the basis of past, present, and probable future operating conditions. It is expected that the northern part of the mound will continue to decline rapidly as a result of sharply reduced volumes going to T-swamp, and that the southern part of the mound will rise slightly and stabilize at about an altitude of 476 ft. as a result of maintaining present disposal rates of about 6 mgd. Thus, increased hydraulic gradients and ground-water velocities to the northeast are expected during the year.

At the request of Geochemical & Geophysical Research Operation, the General Chemical Analysis Operation developed a sensitive analytical method for the detection of 0.1 ppb of fluorescein in well water. The method was used to analyze samples collected during an extensive tracer test southeast of 200-East Area. The injection well was spiked with 100 pounds of fluorescein and water samples were thereafter collected periodically from two observation wells respectively 8800 ft. SSW and 8500 ft. SE of the spiked well. The sample solutions were concentrated from 1 liter to 100 ml. Fluorescein was extracted with isoamyl alcohol and the fluorescence of the alcohol phase was measured with the JACO 2600 fluorimeter. Detectable fluorescein was found in the 8800 ft. well after a time lapse of 28 days, demonstrating, with an ascribed confidence limit of greater than 95%, an average linear velocity of about 350 ft/day. Samples from the 8500 ft. well showed probable fluorescein within 11 days after the start of the test, demonstrating, with a confidence limit of greater than 50%, an average linear velocity of about 770 ft/day.

In order to obtain additional data on the hydraulic characteristics of the aquifers underlying the Hanford Works area, an 8-hour drawdown-recovery test was conducted on well 199-F7-1. A graphical solution of

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recovery data indicates a coefficient of transmissibility of 59,000 gpd/ft and, for a saturated thickness of 15 ft. for the sand and gravel aquifer, a coefficient of permeability of 3,900 gpd/ft^2. Based on these values, a sustained yield for the well of 60 gpm is believed possible, and the average ground-water velocity is calculated to be about 10 ft/day eastward to the Columbia River.

V. WELL DRILLING SUMMARY

TABLE

WELL DRILLING SUMMARY

First Quarter 1957

U. S. G. S.

Well	Ft. Drilled	Finished	Total Feet	To Water?
299-E13-16	57	1/7/57	370	Yes
299-E13-17	358	2/19/57	358	Yes
299-E13-18	458	2/14/57	458	Yes
	873		1186	

The U. S. G. S. drilling crews have completed 902 feet of drilling on the CA-700 Drilling Project and 1,127 feet on the CG-688-PHASE III drilling contract.

Drilling crews of the Hatch Drilling Co. will begin operations sometime during the first week in April. This is a fixed price contract for approximately 5,400 feet of drilling in 251 days.

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