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CHEMICAL EFFLUENTS TECHNOLOGY WASTE DISPOSAL INVESTIGATIONS

JULY, AUGUST, SEPTEMBER, 1958

Prepared by Members of the
Chemical Effluents Technology Operation

Edited by: W. H. Bierschenk

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CHEMICAL EFFLUENTS TECHNOLOGY WASTE DISPOSAL INVESTIGATIONS

JULY, AUGUST, SEPTEMBER, 1958

INTRODUCTION

The Chemical Effluents Technology Operation performs research 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 July-September, 1958.

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 Analyses Operation.

I. INTERPRETATION OF GROUND-WATER MONITORING DATA (W. H. Bierschenk)

Figure 1 shows the probable limits of detectable contamination (gross beta activity > 1.5×10^{-7} μc/cc) in ground water. This detection level is approximately 0.1% of the Radiation Protection Standards MPC for Ru^{106}. Also shown on the figure are generalized contours on the water table as of September 1958. The general direction of ground-water movement is normal to the contour lines in the direction of the downward slope.

200-East Area

There are three zones of contaminated ground water beneath 200-East Area. (See Fig. 1). The depth to water ranges from 200 ft in the northeast part of the area to 340 ft in the southwest. The principal sources of contamination are the waste effluents disposed to the following three general sites:

(1) 216-BY and 241-B cribs. - - These cribs are no longer in use. Nevertheless, wastes continue to percolate from the underlying sediments into the ground water. (See A, Fig. 1). During this quarter the maximum concentration of gross beta emitters detected was 2.4×10^{-2} μc/cc, reported 8/11/58. A significant increase in concentration was noted in two monitoring wells situated southwest of the 216-BY cribs in the 216-BX trench area. The gross beta activity in the water of the monitoring well closest to the BY cribs increased from 2.2×10^{-6} μc/cc in June to 6.8×10^{-4} μc/cc in September. In the more distant well the concentration increased from 2.8×10^{-7} μc/cc to 1.2×10^{-6} μc/cc during the same interval. These wells are

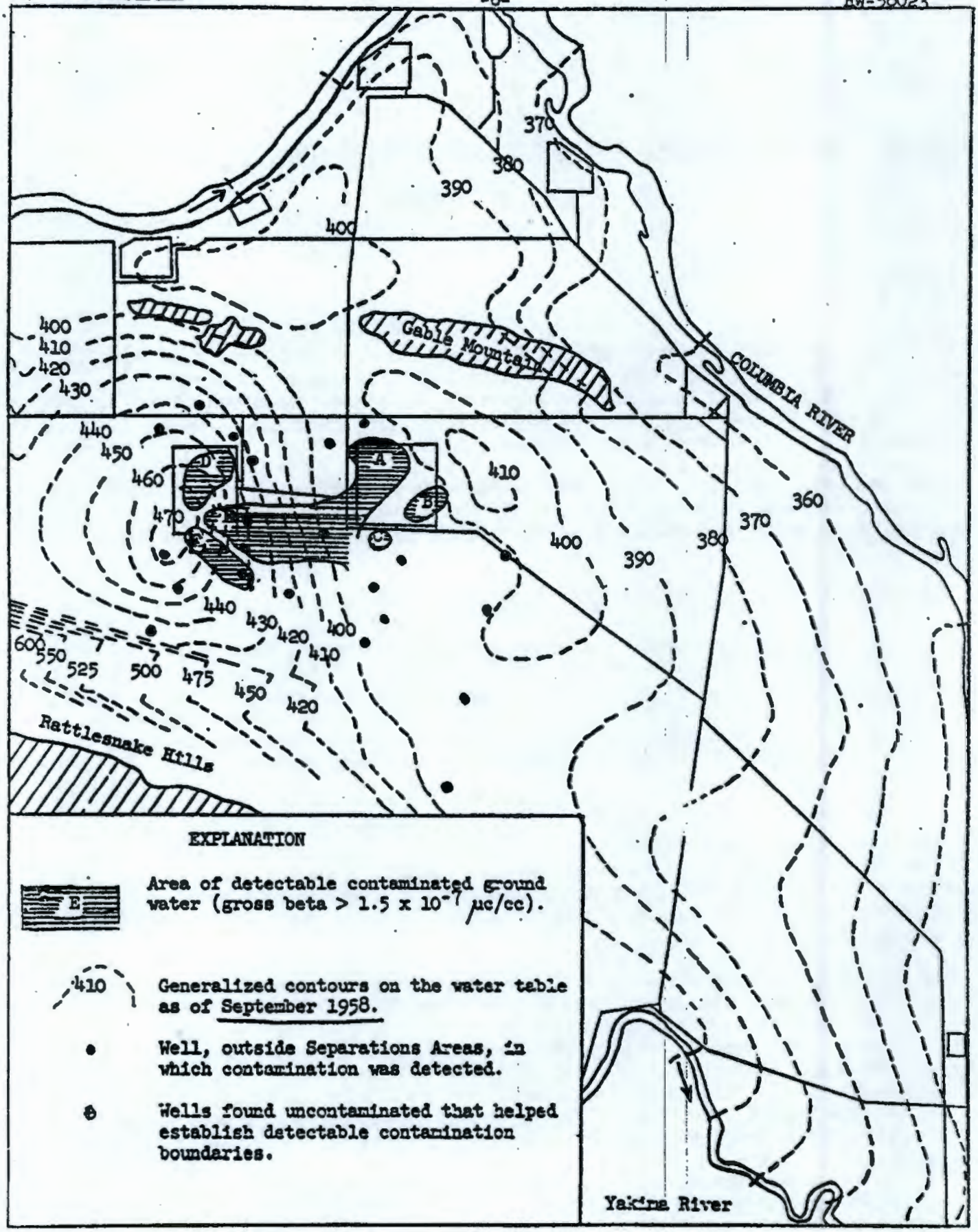

Fig. 1
Map showing probable extent of zones of ground-water contamination and contours on the water table.

down the hydraulic gradient from the BY-area contamination and the increase in concentration may be the result of movement in this direction. However, the possible drainage of BX-crib wastes into the ground-water should not be discounted.

Fission product analyses are made of water samples taken from 13 monitoring wells in this area. As of September, 10 wells contained Co^{60} concentrations within the range 7.0×10^{-5} to 3.4×10^{-4} μc/cc; these concentrations being in excess of 0.1 MPC, which is 4×10^{-5} μc/cc. Sr^{90} and Cs^{137} concentrations were not found in excess of their respective sensitivity levels of 7.0×10^{-8} μc/cc and 7.4×10^{-7} μc/cc. Over the years there has been only one case when Cs^{137} has been detected in the ground water and no case of Sr^{90}. In that case, which occurred in 1956, Cs^{137} was detected in the ground water up to 1,000 feet from the disposal point. At that distance the concentration was 1×10^{-6} μc/cc; this being 1/2,000 of the MPC.

(2) 216-A cribs. - - The concentration of gross beta emitters in the ground water underlying the 216-A-8 crib is decreasing, and that underlying the 216-A-24 is increasing. (See B, Fig. 1). The analyses are summarized as follows:

TABLE I. GROSS BETA ACTIVITY IN 216-A-8 MONITORING WELLS

Well No.	March Samples	September Samples
299-E25-2	1.6×10^{-4} μc/cc	8.5×10^{-5} μc/cc
-E25-4	1.1×10^{-3} " "	2.5×10^{-4} " "
-E25-5	1.6×10^{-3} " "	5.4×10^{-5} " "
-E25-6	3.6×10^{-3} " "	1.3×10^{-4} " "
-E25-7	2.5×10^{-3} " "	1.8×10^{-5} " "
-E25-8	1.1×10^{-3} " "	5.3×10^{-4} " "
-E25-9	2.2×10^{-4} " "	5.4×10^{-6} " "

TABLE II. GROSS BETA ACTIVITY IN 216-A-24 MONITORING WELLS

Well No.	August Samples	September Samples
299-E25-10	6.9×10^{-7} μc/cc	2.6×10^{-5} μc/cc
-E26-2	8.4×10^{-6} " "	9.3×10^{-5} " "
-E26-3	6.7×10^{-5} " "	1.8×10^{-4} " "
-E26-4	3.5×10^{-5} " "	5.6×10^{-5} " "
-E26-5	3.4×10^{-7} " "	3.4×10^{-6} " "

The A-8 crib was taken out of service in May 1958 and the wastes were then diverted to the A-24 crib.

Fission product analyses are made of water samples collected from the six wells monitoring this site and from five other wells located downgradient to the southwest. Sr^{90} and Cs^{137} have never been detected in the ground water beneath the site. In one instance a Co^{60} concentration of 1.95×10^{-6} μc/cc was reported for a sample collected 3/10/58. However, no subsequent sample has ever exceeded the sensitivity level of 8×10^{-7} μc/cc.

(3) 216-BC cribs and trenches. - - The intermittent appearance of gross beta concentrations > 1.5×10^{-7} μc/cc continues. During this quarter, activity was detected in five wells in the area, a maximum concentration of 5.4×10^{-7} μc/cc being reported. (See C, Fig. 1).

200-West Area

It is generally assumed that essentially all the ground water beneath 200-West is contaminated. However, it is possible to discuss three zones. (See Fig. 1). The depth to ground water ranges from about 200 ft in the western part of the area to about 280 ft in the eastern part.

(1) T-Plant cribs and trenches. - - Ground water beneath the T-Plant is contaminated to a maximum gross beta concentration of 6.3×10^{-7} μc/cc. That beneath 241-T and TY facilities has decreased in concentration from about 10^{-5} μc/cc to about 10^{-6} during the past quarter. The greatest detected concentration in this zone (See D, Fig. 1) occurs beneath 241-TX. At this location the gross beta activity declined from 1.3×10^{-4} μc/cc in April to 3.0×10^{-5} μc/cc in September. .63

The water samples collected from five critical monitoring wells are analyzed for fission products. No Sr^{90} or Cs^{137} concentrations were detected exceeding their respective sensitivity levels. The only instance of such an occurrence was early in 1946 when Cs^{137} was detected 100 feet from a crib site in a concentration of 1.4×10^{-5} μc/cc (1/140 of MPC).

(2) Contaminated Zone E (Fig. 1) lies beneath U-Plant but probably results from the continual draining of T-Plant wastes from saturated soil and the subsequent movement of material with the ground water. On 9/16/58 the gross beta concentration in the water sample from the 216-WR monitoring well was reported to be 1.1×10^{-5} μc/cc. On the same date, well 699-38-70, which lies about 0.5 mile eastward and downgradient, reportedly contained a concentration of 3.2×10^{-6} μc/cc.

Samples from the 216-WR monitoring well have never contained positive Sr^{90} or Cs^{137} concentrations.

(3) Redox cribs. - - The 216-S-1, 2 and 216-S-7 cribs continue to be responsible for the contaminated ground water beneath Redox area. (See F, Fig. 1). The maximum reported gross beta concentrations for the quarter are, respectively, 5.0×10^{-4} μc/cc and 7.4×10^{-3} μc/cc. Contamination has extended beyond well 699-35-70, about 0.8 mile southeastward, where a concentration of 1.1×10^{-6} was reported 9/16/58.

Water samples from 11 monitoring wells are analyzed for fission products. All samples collected since 4/2/57 from a well 15 ft from a crib site have contained Sr^{90} concentrations exceeding 7.0×10^{-8} μc/cc. The concentrations reported for recent samples are tabulated as follows:

7/8/58:	1.4×10^{-6} μc/cc
7/15/58:	1.8×10^{-6} " "
8/12/58:	6.3×10^{-7} " "
9/19/58:	7.9×10^{-7} " "

II. PLANT WASTE DISPOSAL PRACTICE

Chemical Processing Department (W. A. Haney)

Storage of high-level wastes. - - Five field-scale tests were performed to simulate loss of Redox waste through a leak in an underground storage tank. The test equipment consisted of a 7' x 7' x 1/2" steel plate with an 8' long, 3" diameter, standpipe mounted normal to the plate at its center point. A 1" orifice was installed in the standpipe flush with the bottom of the plate. The plate was buried horizontally, 6 - 7 feet deep in pits immediately south of the 241-SX tank farm. Synthetic D-8 waste solutions, prepared in mixing tanks at the 321 Building, were transported to the test site in a tank trailer. The trailer valve was connected to the top of the standpipe with a hose, and the waste was permitted to flow by gravity into the standpipe. The apparatus was modified for the last three tests by adding a sparge line immediately above the orifice to maintain the sludge in suspension.

The waste employed in the first test (waste #1) was typical of the D-8 stream discharged from the plant to the underground tanks. This solution contained precipitate equal to about 5% of the waste volume. Synthetic waste employed in the later tests (waste #2) was equivalent to tank-stored waste that had self-concentrated to 80 - 83% of the original volume. This waste contained about 20% by volume of a rapid settling precipitate. The

calculated compositions of the wastes are as follows:

Component	Concentration (Molar) Waste #1	Waste #2
$NaAlO_2$	1.44	1.6
$NaNO_3$	4.32	5.4
$NaOH$	1.45	0.5
Na_2CrO_4	0.17	0.20
$Fe(OH)$	0.02	0.04
Na_2SO_4	0.04	0.08
Specific gravity	1.359	1.463

Results of the five tests are summarized in the following table:

TABLE III - RESULTS OF SIMULATED LEAK TESTS

Test No.	Type of Waste	Volume Discharged (gallons)	Duration of Test (min.)	Fluid Head (Ft. of waste)	Remarks
1	waste #1	1050	240	0-6	Rapidly dispersed in soil
2	waste #2	50	2(days)	13	Orifice plugged by sludge
3	" " #2	95	5	13	Waste erupted at surface
4	" " #2	50	5	14	" " " " " "
5	" " #2	65	90	11	" " " " " "

The results of the first test indicated that the unconcentrated waste was rapidly dispersed in the underlying soil. Visual examination of the soil under the plate, together with nitrate ion analyses of soil samples, showed that the waste migrated to a depth of about four feet below the orifice and horizontally to a distance of ten feet from the orifice.

The high sludge content of the waste employed in the second test rapidly plugged the orifice which made it necessary to add the sparge line in later tests. In the last three tests the waste erupted at the ground surface soon after the tests were started and after only a small volume of waste had been discharged. Examination of the soil under the test plate revealed considerable sludge build-up at the plate-soil interface. This precipitate cake reduced the vertical infiltration rate to such an extent that the waste was forced to the surface through the backfill material. This finding suggests that previous estimates concerning "maximum permissible leak before detection" may have been conservative.

HW-57088, "Interim Report - Simulated Leak in an Underground Redox Waste Storage Tank," was issued on August 8, 1958. This report summarizes the results of the first two field-scale tests and describes the test equipment and procedures.

Disposal to the ground. - - Recommendations concerning future neutralization of the process condensate wastes discharging to the 216-WR-1, 2 and 3 cribs (U-Plant) and the 216-A-5 crib (Purex) were forwarded to the Chemical Processing Department. These wastes which are presently neutralized with limestone have exhibited poor Sr^{90} soil adsorption characteristics due to the relatively high calcium ion concentrations. It was recommended that caustic addition facilities be provided for neutralizing these streams when the replacement cribs are placed in service.

Irradiation Processing Department

Reactor decontamination (W. N. Koop)

Irradiation Processing Department, in an effort to develop a method to reduce personnel exposure rates in reactor discharge areas, has flushed individual process tubes with the chemical cleaner Turco 4306-B. Analyses of the effluent from these tests indicated that a large quantity of radioactive material will be removed during a full reactor decontamination. The quantity is so large that direct river disposal cannct be permitted at least for the first few full scale tests. In an effort to develop an adequate disposal method, experiments with the spent cleaning effluent were conducted by Chemical Effluents Technology. The first experiment was devised to determine if the radio-elements could be precipitated either by treatment with caustic or by diluting the spent cleaning solution in water. In each of four cases the spent cleaner was treated and filtered through a sintered glass funnel, then both the filtrate and material retained in the funnel were analyzed for five radioisotopes. Dilutions of spent cleaner in reactor coolant, as much as one part in fifty, caused no precipitation of Cr^{51}, Zn^{65}, P^{32}, Fe^{59}, and Sc^{46}. Ten to fifty percent precipitation of these isotopes was noted when one part spent cleaner was diluted in a thousand parts of Columbia River water. Neutralizing the spent cleaning solution with NaOH caused nearly all (85 to 99%) of each of the five isotopes to precipitate. This indicated that caustic treatment of effluent was worthy of further investigation and provided the incentive for the second experiment in which treated cleaning solution was sent through soil columns. This was done to determine the effect of pH on precipitation of radioisotopes and on their removal by the soil under simulated trench disposal conditions. Another objective of the second experiment was to determine the ability of the soil to retain the precipitate, and to retain rupture debris under trench conditions existing after disposal. Processing of spent cleaning solutions

through laboratory soil columns was completed during the period but evaluation awaits completion of the analytical work.

Uranium oxide experiments (R. K. Hilliard)

A laboratory investigation of the uranium-air reaction at high temperatures showed that the reaction rate is a complex function of time and temperature. Neither the specimen temperature nor the surface area remained constant with respect to time. Therefore, all results were necessarily correlated with parameters of furnace temperature and original surface area. Air flow rate also was found to affect the reaction rate slightly.

The amount of uranium reacted was measured as a function of time for four different specimen sizes at a constant furnace temperature of 805° C. The weight oxidized increased parabolically for 10-20 minutes, then became generally linear until the specimen was entirely consumed. A few spurious results could not be fitted to the curves, but most of the results were reproduceable to within ± 10%.

The average rate for the first ten minutes of the reaction was measured at furnace temperatures up to 1450° C. An Arrhenius plot of this rate versus $1/T$ on semi-logarithmic paper showed two straight lines intersecting at a furnace temperature of 620° C. The apparent activation energy below 620° C was 12.5 K cal/mol, while above 620° C it was 7.2 K cal/mol. Data are being gathered for similar plots using different specimen sizes.

The break in the curve of rate versus $1/T$ is believed to be caused by a change in the physical properties of the reaction product. Below 620° C the oxide exists as a fine powder which does not adhere to the metal surface. Air diffuses readily through the thin oxide film. Above 620° C the oxide exists as a hard granular scale which adheres tenaciously to the metal. Air diffusion through this scale is probably the limiting rate mechanism. Since the oxygen/uranium ratio is the same for both types of oxide, the difference in physical characteristics must be caused by sintering at the higher temperatures.

The metal temperature was measured by inserting a thermocouple in a hole drilled into the specimen. The specimen temperature rose above the furnace temperature for all reactions tested at furnace temperature from 300-805° C. The manner in which the specimen temperature behaved depended on the furnace temperature, however. Below 400° C it remained constant at a value slightly higher than the furnace temperature.

Within the furnace temperature range of 400 - 620° C, the metal temperature fluctuated in a cyclic manner. Temperature excursions as high as

500° C above the furnace temperature were recorded. These temperature peaks lasted 3 to 5 minutes and were repeated in an irregular manner every 10 to 20 minutes. This thermal cycling was always preceded by a period of relatively constant specimen temperature termed as "induction period." Above 620° C the specimen temperature rose rapidly to the melting point of uranium, then decreased steadily during the remainder of the reaction period.

The "induction period" was found to decrease exponentially with furnace temperature within the range of 400 - 620° C according to the equation:

$$t_{i.p.} = 4800e^{-0.00824T}$$

where $t_{i.p.}$ is the induction period in minutes and T is the furnace temperature in °C.

The time required for complete oxidation of the specimen was measured for three different cylindrical specimen sizes at a furnace temperature of 805° C. The relationship between the original weight/area ratio and the time required for complete oxidation is expressed by the equation:

$$tc = 69\frac{W_o}{A_o} - 45$$

where tc = time required for complete oxidation of the specimen (minutes).

W_o = original weight (grams).

A_o = original surface area (cm^2).

Extrapolation of the data to a weight/area ratio corresponding to the size of a normal Hanford reactor slug gives a value of about 17 hours required for complete oxidation at 805° C furnace temperature.

III. LABORATORY EVALUATION OF WASTES (H. L. Brandt).

A significant quantity of plutonium is discharged to the ground in CAW waste. The average Pu concentration in this waste for seven months in 1958 was 0.008 g/l or 4.9×10^{-2} uc/l. During that period 406,000 liters of waste were discharged to the ground, containing about 3.2 kg of plutonium.

Laboratory soil column experiments and equilibrium tests show that soil uptake from this solution is low. Ground-water monitoring for Pu at this crib must await the completion of a well drilled to the water table. The waste contains, among other components, 1 M Al^{+++} and 0.5 M Mg^{++}. High

concentrations of such polyvalent ions compete strongly for the available cation exchange capacity of the soil.

Some evidence exists to indicate that the 2 M HNO_3 in CAW before neutralization induces the formation of anion complex. This idea was given credibility when amberlite IRA 400, an anion exchange resin, in a laboratory equilibrium experiment removed about 25% of the alpha emitters from CAW solution.

Radiochemical analyses of the solution showed that 23% of the total alpha-emitting isotopes was Pu^{239} and that the remainder was probably Am^{241}.

Purex process condensate.- An unusually low soil uptake of Sr^{90} from the limestone-neutralized Purex process condensate led to a study of this system. Results showed that the large calcium ion concentration was responsible. Details are given in the Chemical Effluents Technology report HW-57002-RD, for April-June, 1958. The soil uptake of Sr^{90} during the column operation was greater for the unneutralized condensate than for the same stream after it was neutralized with limestone. Under batch conditions, however, the soil removal of Sr^{90} was much better from the neutralized stream, as indicated by the distribution coefficients. The neutralized stream had a K_d of 8.3. A subsequent equilibrium experiment was made in which the soil was preleached with acid. In the latter case the calcium and other acid-soluble components, which apparently were interfering with the Sr^{90} uptake, were removed. As a consequence the strontium uptake more than doubled for the unneutralized stream. Thus the batch results became consistent with the column performance.

TABLE IV. DISTRIBUTION COEFFICIENTS FOR UNNEUTRALIZED PUREX CONDENSATE WITH LEACHED AND UNLEACHED SOIL

Leaching treatment	K_d
0.1 N HNO_3 (quantity of acid used was equivalent to carbonate in soil)	6.5
0.1 N HNO_3 (twice the quantity of acid above)	6.4
No leaching treatment	3.0

U-Plant condensate.- - The U-Plant condensate is acid with nitric acid. Its pH is less than one. As previously reported, the soil uptake in the WR 1, 2, and 3 cribs from the limestone-neutralized condensate is practically negligible due to the large concentration of calcium ion. Tests are now being run to determine (1) the feasibility of disposal of the unneutralized condensate and (2) the relationship between soil uptake of strontium and the pH as the latter is increased by the addition of sodium hydroxide.

Disposal of decontaminating agent. - - Laboratory soil column and equilibrium tests have provided disposal data for Turco-4501, a detergent for equipment decontamination. This reagent is being tested for possible plant use.

A 5% water solution of the detergent in soil previously unused for waste disposal has the following capacity for strontium and cesium.

Radionuclide	Concentration of influent	Uptake capacity in soil column volumes
Sr^{90}	8×10^{-4}	3.5
Cs^{137}	1.5×10^{0}	1.1

A comparison of the quantitative soil uptake of plutonium may be gained from the equilibrium data given in Table V. Note that for disposal purposes the MPC must be considered.

TABLE V. DISTRIBUTION COEFFICIENTS FOR RADIONUCLIDES IN TURCO-4501

Radionuclide	K_d*	MPC (μc/cc)
Cs^{137}	7.2	2×10^{-3}
Pu^{239}	87.5	3×10^{-6}
Sr^{90}	89.7	8×10^{-7}

*K_d is the ratio of the unit concentration of the radionuclide in the soil to the unit concentration in the solution at equilibrium.

IV. GROUND-WATER HYDROLOGY (W. H. Bierschenk)

Field tests

Hydraulic field tests were completed on four wells. The results of the analyses of drawdown-recovery data are summarized in the following table:

TABLE VI. RESULTS OF PUMPING TESTS

Well No.	Aquifer tested	Transmissibility gpd/ft	Average permeability gpd/ft^2
699-42-12	Glaciofluviatile plus Ringold sediments	645,000	5,000
699-26-15	(same as above)	65,000	1,450
699-35-9	Ringold	54,000	420
699-17-5	Ringold	8,500	190

Tentative evaluation of all hydraulic data obtained to date indicate that

the average field coefficient of permeability of the Ringold formation ranges in the order of 100-600 gpd/ft^2. For an aquifer composed of both Ringold and glaciofluviatile sediments the average permeability ranges from 1,000 - 5,000 gpd/ft^2, and for glaciofluviatile deposits if ranges from 12,000 - 66,000 gpd/ft^2. In other words, the glaciofluviatile deposits appear to be roughly 100 times more permeable than the Ringold sediments.

A step-drawdown test was performed on well 699-26-15. Such a test permits evaluation of the performance of the well itself through determination of the head loss of the well resulting from turbulent flow in the zone outside the well and through the well perforations. The fraction of the total drawdown observed in a pumping well attributable to turbulent flow is called "well loss." This well had been perforated with 2 holes per round and 1 round per foot for the full 45 ft of the effective aquifer. The well-loss constant determined for these conditions was calculated to be 9.0×10^{-5}. An additional 96 perforations were then jetted by the shaped-charge technique and another step-drawdown test completed. The well-loss constant was then calculated to be 1.2×10^{-5}, a 7-1/2-fold reduction.

The shaped-charge perforating technique was also applied to well 699-9-E2. Unfortunately, the thin-walled Kai-well casing did not stand up to the blast and it parted somewhere just below the water table. It is recommended that in the future Kai-well casing not be subjected to jet perforating.

Laboratory tests

The centrifuge technique for determining the specific retention capacities of Hanford sediments was further tested and evaluated. Samples of Touchet sediments were saturated with solutions of distilled water, with an unconcentrated synthetic waste (1X), and with a synthetic waste concentrated to half-volume (2X). The samples were subjected to a force of 1,000 gravities for one hour, and the following percentages by weight were retained by the sediments:

Water : 15%
1X : 17%
2X : 19%

The data collected to date appear to indicate that the centrifuge drainage equation is not completely adequate for determining the equivalent time of gravity drainage.

V. WELL DRILLING SUMMARY (D. J. Brown)

Artesian Well & Pump Company

Well	Ft. drilled	Finished	Total ft.	To water?	To basalt?
299-E26-4	0	7/1/58	283	Yes	No
299-E25-10	68	8/3/58	293	"	"
299-E36-3	274	7/14/59	274	"	"
299-E26-2	267	7/17/58	267	"	"
699-33-56	154	7/28/58	440	"	"
	763		1557		

The Artesian Well & Pump Company has completed eight of the nine wells on the AT (45-1)-1255 drilling contract. Approximately 200 feet remains to be drilled in the final well, 299-E13-20C. Drilling difficulties have necessitated relocating this well twice, hence, the designation 299-E13-20C. There still remains a step-drawdown test and a pumping test to be performed in wells 699-33-56 and 699-31-53. However, there is a question about the usefulness of the data that would be obtained for well 699-31-53 inasmuch as the driller reported that while attempting to pull back the 12-inch casing in this well to expose the well screen, the 12-inch casing parted, leaving a significant portion of the screen unexposed. The contract completion date expired on July 15, 1958.

The Bach Drilling Company is drilling two wells on the AT (45-1)-1282 drilling contract issued by the Hanford Laboratories Operation. This contract calls for the construction of eleven wells, with a total footage of approximately 3,800 feet. With one exception, these wells will be drilled to the basalt bedrock and will be maintained as hydrological test wells and as ground-water monitoring wells. The scheduled completion date for this contract is December 31, 1958.

The Midland Drilling Company of Walla Walla, Washington, was low bidder for the drilling contract issued by the Chemical Processing Department on August 4, 1958. This contract, AT (45-1)-1406, is for eight wells. These wells are to be drilled in the vicinity of the 234-5 area for the purpose of monitoring the radioactive wastes going to the 216-Z-9 and Z-12 cribs. On September 29, 1958, the contract was modified to include one other well to be drilled in the 241-SX tank farm area. This well, 299-W23-72, is scheduled to be drilled 100 feet deep.

The Midland Drilling Company is using a new drilling technique for making hole. The technique employs a drive barrel mounted on the drilling stem instead of the regular hard rock bit. The technique combines the two operations of drilling and bailing into one. Of most significance is that no water is required for dilling, the sediment samples are not fractured or crushed, and the method is apparently faster and cheaper than the drill and bail method.