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CHEMICAL EFFLUENTS TECHNOLOGY WASTE DISPOSAL INVESTIGATIONS

JANUARY-JUNE, 1963

#37

Edited

by

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Geochemical and Geophysical Research
Chemical Effluents Technology
CHEMICAL LABORATORY

HANFORD LABORATORIES

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HANFORD ATOMIC PRODUCTS OPERATION

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CHEMICAL EFFLUENTS TECHNOLOGY WASTE DISPOSAL INVESTIGATIONS

JANUARY-JUNE, 1963

I. INTRODUCTION

The Chemical Effluents Technology Operation performs research to investigate the chemical and physical aspects of environmental contamination resulting from the disposal of plant effluents or from potential process incidents. This is a semi-annual report, published to give the latest information on the status of contamination in the ground water arising from waste disposal operations in the Separations Areas.

Three maps are included in this report. One shows the extent to which gross beta-emitters are distributed in the ground water. Changes in the ground-water contamination pattern, found by comparing the most recent map with that for the previous report period, are noted and where possible are interpreted in consideration of waste disposal practices and the latest geological and hydrological knowledge of the region. A second map shows the tritium contamination distribution in the ground water. The third map shows the extent of nitrate ion contamination in the ground water where it exists in concentrations greater than 10 ppm; also delineated on this map is the zone where the concentration exceeds the U. S. Public Health Service drinking water standard of 45 ppm. For comparison, the maps issued during the last report period can be found in Document HW-76120-RD.

Where possible the contamination in the ground water is identified with a particular source area or crib. In some cases, however, the contaminants have migrated far enough from the source area that such definition is no longer possible.

Ground water monitoring results utilized in this report were obtained from samples collected routinely by the Environmental Monitoring Unit and analyzed by the Radiological Chemical Analysis Operation.

Well structures at Hanford are identified according to their location on the plant. The first group of numbers (199-, 299-, 699-) identifies the general area (100, 200, 600) in which the well is located. In the 100 and 200 Areas the second group of numbers (B3, E24, W22) identifies the particular area and the sheet map encompassing that portion of the area in which the well is located. The third group of numbers identifies specific wells generally in the chronological order in which they were drilled. In the 600 Area the second and third groups of numbers express in thousands of feet the nearest plant coordinates; the north coordinate is the second group of numbers and the west coordinate is the third group. Wells located south and east of the origin of the plant coordinate system are identified by the letters "S" and "E" in front of the coordinates.

II. INTERPRETATION OF GROUND WATER MONITORING DATA

Special Monitoring Wells Samples

During this report period large-volume samples were obtained from six selected wells which monitor the movement of radiocontaminants from 200 Area ground disposal sites. The samples were given special analytical processing to determine the concentrations of long-lived fission products of concern in separations wastes. The results of these analyses appear in Table I.

Concentrations of Sr^{90}, which were barely detectable in several samples taken from Wells 299-E13-13 and 699-34-51 (Site C, Figure 1) during the last six months

TABLE I

RADIOISOTOPIC ANALYSES OF SPECIAL MONITORING WELL SAMPLES

(Concentrations in Units of 10^{-8} μc/cc)

Isotope	299-W22-5	299-W22-8	299-W22-10	299-W22-14	299-E24-2	699-20-E12 **(P-1)	699-20-E12 **(P-5)	MPC_w *
Total α	< 2	< 4.1	< 3.4	< 2.2	< 0.72	< 1.9	< 1.6	--
Ru^{106}	1,500	21	130	130,000	49,000	140	21 ± 16	10,000
Sr^{90}	< 0.8	< 1.7	< 1.2	< 15	< 8.6	< 1.5	< 0.6	100
Co^{60}	< 440	< 440	< 440	< 440	< 440	< 440	< 440	50,000
Cs^{137}	< 1.3	< 1.3	< 1.3	< 1.3	< 1.3	--	--	20,000
H^3	1.9×10^6	4,300	8.1×10^5	2×10^7	3.1×10^6	< 180	210 ± 90	3,000,000

*Recommended maximum permissible concentration in drinking water for continuous occupational exposure. U. S. Department of Commerce, N.B.S. Handbook 69.

**Well 699-20-E12 is shown at Site A on Figure 1. The "P- number" following the well designation indicates the piezometer tube from which the sample was obtained. In this case samples were taken from the bottom piezometer (P-1), which taps the lowermost aquifer, and from the well casing (P-5) which taps the aquifer near the ground-water surface.

of 1962, are now below the detection limit of 3×10^{-8} μc/cc. The twenty wells which monitor the 216-BC scavenged waste cribs and trenches at Site C were surveyed recently with the in-well gamma scintillation probe to determine the extent to which radionuclides (principally Ru^{106}) had penetrated the unsaturated soil column beneath these disposal facilities. In all cases but one the radiocontaminants were found to terminate at a distance of at least 100 feet above the ground-water table. The single exception was the 299-E13-20 well, located southeast of the BC-5 crib, in which low concentrations of gamma emitters were detected intermittently all the way to the water table. Water samples from this well, however, have consistently shown gross beta-emitter contaminations to be less than the routine detection limit of 8×10^{-8} μc/cc; it is likely that the contaminants detected by the probe are the result of drilling "carry-down" since this is the only well at the site which was drilled following the disposal of wastes. The unexpected appearance of low concentrations of Sr^{90} in the two wells at the 216-BC facility may well have been due to an outside source of the radionuclide rather than to waste discharged at this site. Scavenged waste was very high in NO_3^- ion and Ru^{106} (ca. 200,000 ppm NO_3^- and 7 μc Ru^{106}/cc, respectively), and these poorly scrbed ions normally serve as precursors to the more efficiently removed cations. However, neither NO_3^- nor Ru^{106} has been detected in appreciable concentrations in wells at this site. Also, wastes disposed to these cribs and trenches were evaluated batchwise for Sr^{90} and Cs^{137} removal in laboratory soil column tests prior to and following disposal, and volumes discharged were regulated strictly so that these long-lived nuclides would not reach the ground-water zone. Recently water samples from these two wells were filtered,

and the residue was sent to Biology Operation for identification. A seed covering from a millet-type grain common to the 200 Area swamps was found in a sample from the 699-34-51 well. No decayed animal matter was evident, but in some instances rabbits, desert mice, and animal droppings containing low levels of radiocontaminants have found their way into project monitoring wells.

The appreciably greater Ru^{106} concentration noted in the sample from the lowermost piezometer tube (P-1) in well 699-20E-12, in comparison with the result from the top aquifer (P-5), probably is the result of more rapid ground-water movement in the lower aquifer. Piezometer tubes installed in four wells adjacent to the river showed the fluid head in the lower aquifer to be from 20 to 30 feet greater than the elevation of the water table. Such a condition is common due to the configuration of the potential pattern in the ground-water zone near a river. Also, part of the hydraulic head difference may be due to a locally confined aquifer, the Prosser Interbed, between the Saddle Mountain #2 and #3 basalt flows.

200-East Area

Figure 1 is a map of the 200 Areas showing the extent of detectable ground-water gross beta contamination as indicated by analyses of routine samples collected during the period January-June, 1963.

The gross beta activity in the ground water beneath the 216-A-10 Purex Process Condensate Crib continued to increase during this report period reaching a high of 7×10^{-3} μc/cc in April. The increased activity in this waste stream is the result of a process change to single-cycle acid recovery, vice two-cycle recovery, made in September, 1962. Analyses of crib influent samples indicate that Ru and Zr-Nb

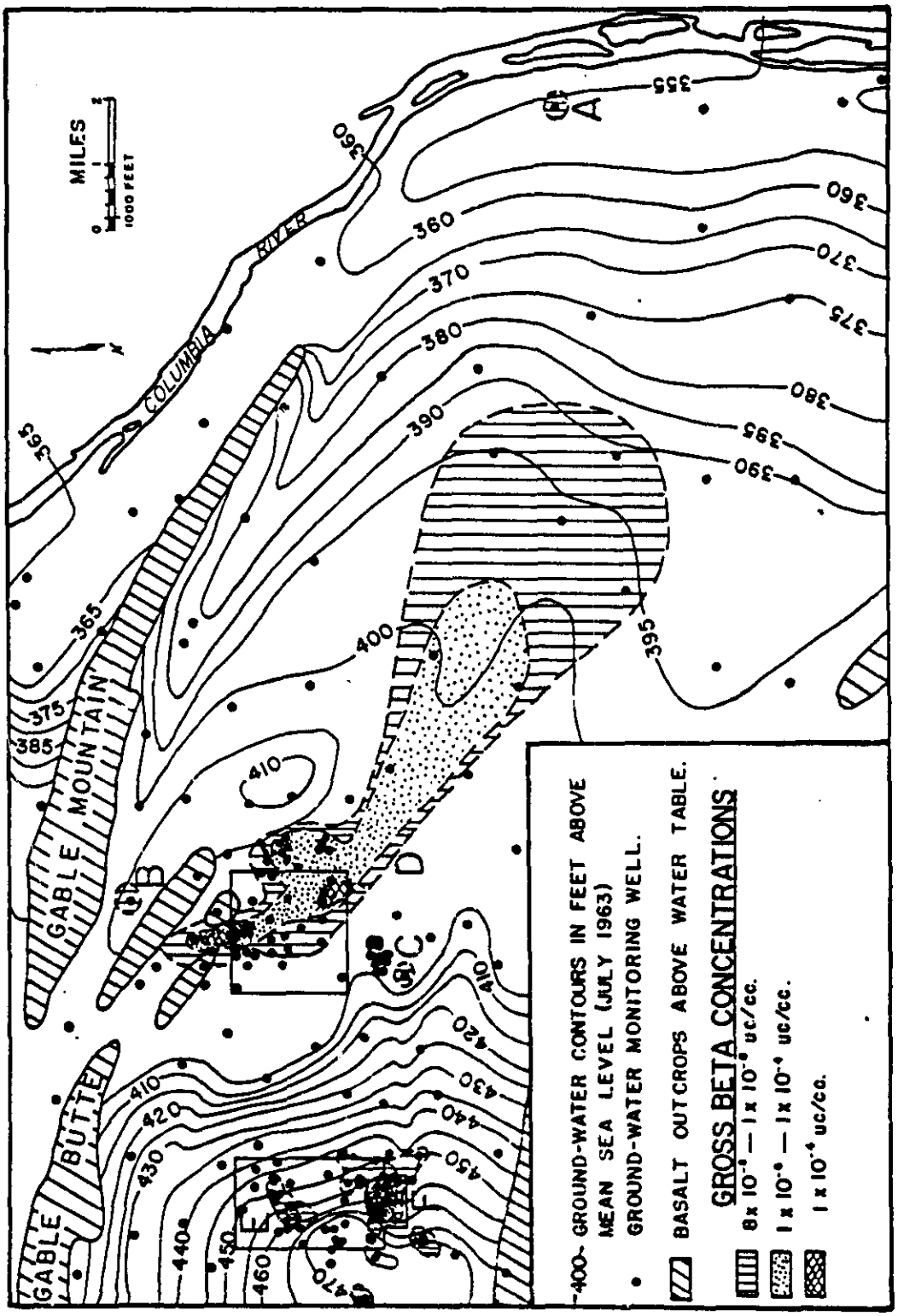

FIGURE 1.
Probable Extent Of Ground Water Gross Beta Contamination January - June, 1963

January - July 1963

radionuclides constitute the bulk of the increase in activity. Strontium-90 concentrations in the influent continue to be relatively low, averaging 2 - 5 x 10^{-7} μc Sr^{90}/cc. Chemical addition to the concentrator started in March, 1963, was effective in reducing appreciably the volatile Ru activity in the waste stream. Rerouting the F-5 acid absorber overheads back through the process, which is another proposed process change, may well reduce the concentration of radioisotopes in the process condensate stream to values lower than those experienced under two-cycle acid concentration.

The increase in activity of the waste going to the 216-A-10 Crib has been evident only in those monitoring wells fairly close to the cribsite. More distant wells monitoring the contaminated ground-water plume from the Purex Plant (Site D, Figure 1), have not yet reflected the increased activity in the waste. Previous investigations indicate that it may be several years before radionuclides in current wastes reach wells located 4 to 5 miles from 200-East Area. The sustained period of higher activity discharge, about one year, and the magnitude of the increase are probably sufficient to assure detection in the more distant wells.

A comparison of the gross beta ground-water contamination maps for the present and previous report periods shows a receding of the lowest-level contamination zone away from the river. This is attributable to analytical results from wells near the perimeter of the zone. Previously these results were only slightly above the routine detection limit of 8 x 10^{-8} μcβ/cc; currently they are below the detection limit. Such small fluctuations are probably due to relatively minor sustained changes in the concentrations of radionuclides and/or the quantity of waste discharged to ground in 200-East Area.

Beta activity in the well shown at Site B, Figure 1, probably is a result of low concentrations of radiocontaminants contained in Purex Plant cooling water discharged to the Gable Mountain Swamp during this period.

There were no significant changes in the ground-water contamination patterns at Site C or in the northern portion of 200-East Area. Cobalt-60 remains detectable in several wells at the latter location. The maximum concentration reported during this period was 2.4×10^{-5} μc Co^{60}/cc in well 699-50-53.

200-West Area

Two major areas of ground-water contamination in 200-West Area are shown on Figure 1 as Sites E and F. The only significant change noted in the contaminated ground water pattern under 200-West Area has been the continual receding of the areal extent of contamination. This is due to appreciable reductions in the quantity of radioactive material cribbed from the Redox Plant, initiated in 1958, and to the decay of the low concentrations of Ru^{106}-Rh^{106} in the ground water east of the area. Quite evident too is the slower rate that ground water under 200-West Area moves relative to that under 200-East Area. Average gross beta-emitter concentrations for the two sites in 200-West Area were calculated and maximum values are reported in Table II, together with the maximum values for the previous six months.

TABLE II

AVERAGE CONCENTRATIONS OF GROSS BETA ACTIVITY IN 200-WEST AREA WELLS

Site	Well Number	July-December, 1962	January-June, 1963
E	299-W14-2	3.5×10^{-7} μc/cc	3.2×10^{-6} μc/cc
F	299-W22-14	3.2×10^{-3} " "	2.7×10^{-3} " "

The intermittent positive Sr^{90} analyses of samples from the three wells monitoring the Redox 216-S-7 Process Condensate Crib (see Page 10, HW-76120-RD) prompted a more concentrated sampling program at this locale in March. Analysis of samples obtained from the three wells over three successive days showed positive Sr^{90} results in eight of the nine samples. The maximum concentration detected was 2.6×10^{-7} µc Sr^{90}/cc in well 299-W22-12. The relatively high Sr^{89}/Sr^{90} ratio indicated that the waste was fairly "new", and that the source of the Sr^{90} was not the 216-S-1 & 2 Cribs (located about 800 feet to the northwest) which were abandoned in 1956. Recommendations were made to the Chemical Processing Department that a replacement facility be constructed. Strontium-90 is still present in well 299-W22-2 which penetrates the gravel fill of the 216-S-1 & 2 Cribs. The maximum concentration reported this period was 3.1×10^{-6} µc Sr^{90}/cc.

III. FISSION PRODUCT TRITIUM IN THE GROUND WATER

Figure 2 shows fission product tritium contamination in the ground water as a result of waste disposal operations in the 200 Areas. The major sources of this radionuclide are the process condensate and tank farm condensate streams at the Purex and Redox Plants. Lesser quantities are present in the Purex acid fractionator condensate which discharges to the B-swamp.

The most noticeable change in the ground-water contamination patterns was in the area south of Gable Mountain. Previously several of the wells in that region contained concentrations of tritium slightly greater than the routine detection limit of 1×10^{-5} µc/cc. Minor changes in volumes of waste cooling water disposed to the Gable Mountain and B-swamps, and fluctuations in tritium content of the waste

are the probable reasons for the tritium concentration in these wells being below the detection limit (except for the two wells at Sites A and B, Figure 2) during this report period.

Beginning in about July, 1963, samples from wells which are near the perimeter of the lowest tritium contamination level zone or in the probable path of contaminant movement will be analyzed by newly-adopted techniques. In one procedure, a refinement of the presently-used liquid scintillation counting method, the detection limit will be about 2×10^{-6} μc H^3/cc. Even lower detection limits, 1×10^{-7} to 5×10^{-9} μc H^3/cc, are attainable by concentrating the tritium through electrolysis; this method will be employed for processing samples from a few of the outlying wells which are of current interest. The tritium contamination map for the next report period will probably include zones based on the lower detection limits. Certainly the apparent inconsistencies in the patterns presented in the first three tritium contamination maps should be better resolved by using these new analytical methods.

IV. CONTAMINATION OF THE GROUND WATER BY NITRATE ION

Figure 3 shows nitrate ion concentrations in the ground water in the vicinity of the 200 Areas. Nitrate ion concentration patterns are quite similar to the contamination patterns shown on the gross beta and tritium maps.

The major source of nitrate ion in 200 East Area is the Purex process condensate waste discharged to the 216-A-10 Crib. Lesser amounts enter the B-swamp via the vacuum acid fractionator overheads. This is the probable source of the low-level zone shown at Site B. The nitrate ion plume (Site A) from the 216-A-10 Crib appears fairly stable in areal extent; however, recent changes in the Purex

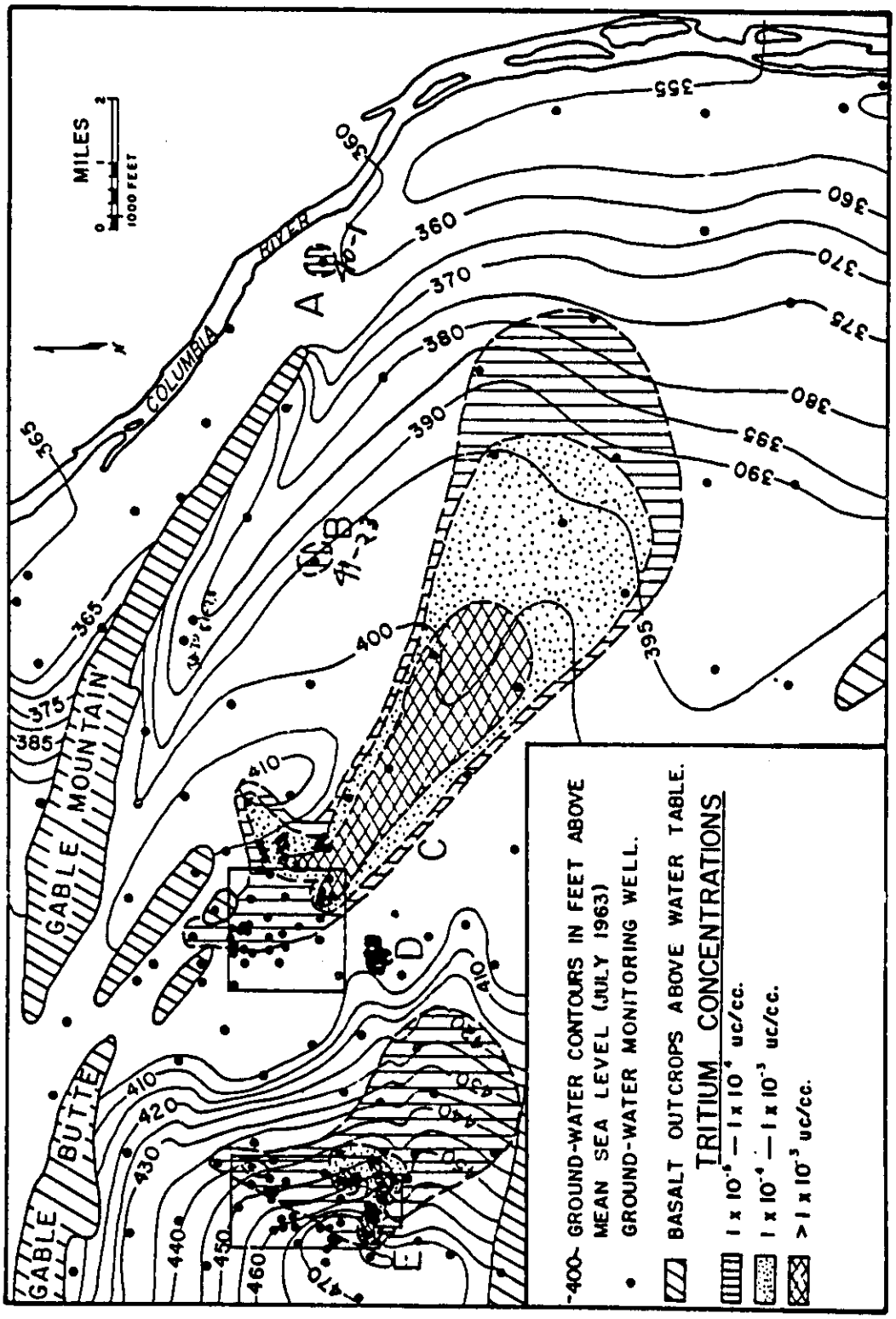

FIGURE 2.

Probable Extent Of Ground Water Tritium Contamination January - June, 1963

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January - June 1963

process may result in the plume extending several miles to the east.

Major current sources of nitrate ion in 200-West Area are condensate streams at the Redox and U Plants. Remnant high concentrations of nitrate ion remain in the ground water in the vicinity of T-Plant due to earlier disposals of waste from operations there. Only minor changes have been noted in the nitrate ion contamination patterns under 200-West Area over the past several years. Also, no significant changes are anticipated in these patterns in the near future, primarily due to the relatively slow rate of ground-water movement in the region of 200-West Area.

V. WELL DRILLING (R. E. Brown)

No wells were drilled on the Project during this report period. Planning for the FY-1964 well drilling requirements is in progress. As currently envisioned this will consist of about 4 wells (most of them drilled adjacent to the river between the 300 Area and Hanford Townsite) and the cleaning-out and perforating of a number of existing wells to improve their monitoring usefulness.

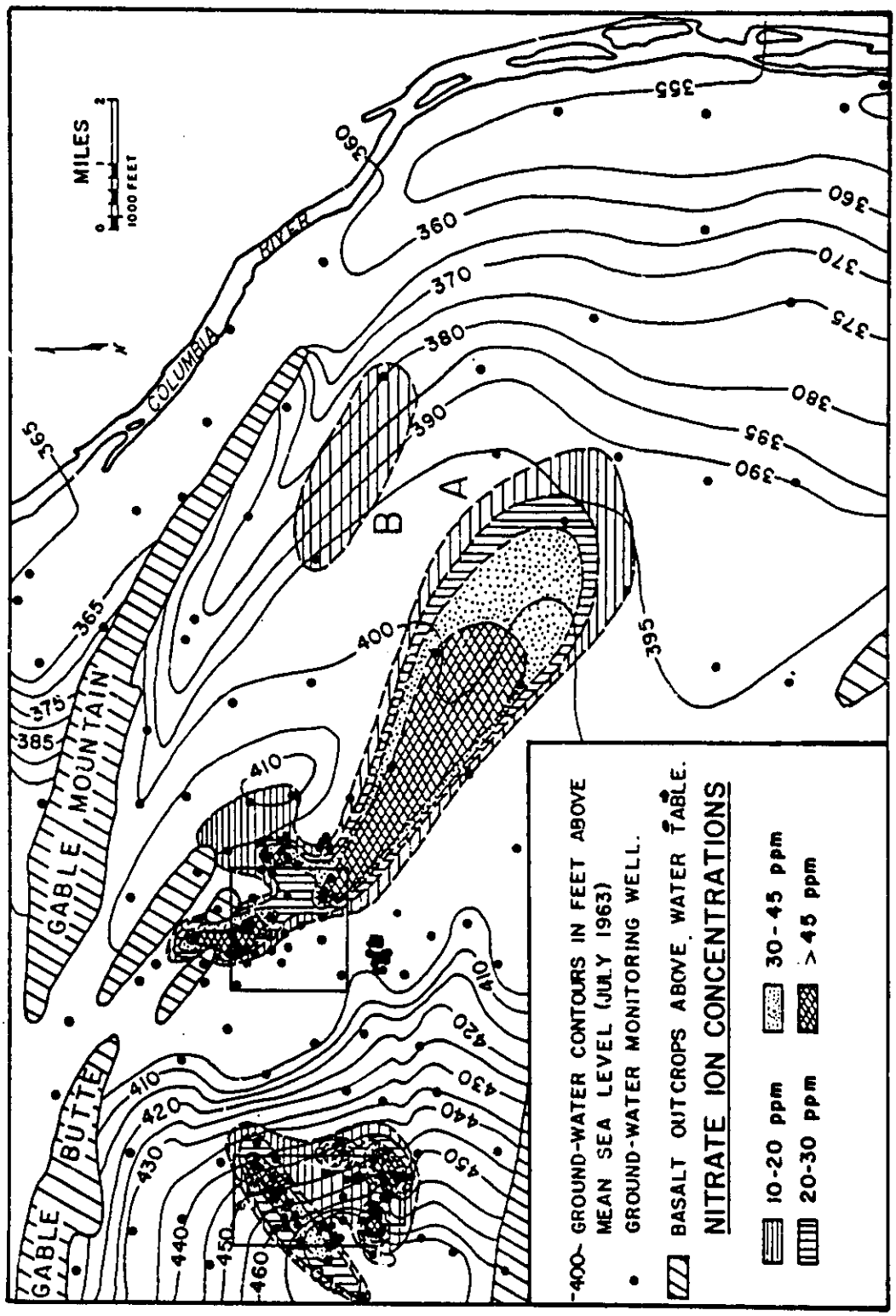

FIGURE 3.
Probable Extent Of Ground Water Nitrate Ion Contamination January - June, 1963

January - June 1963

VI. APPENDIX

TABLE III

AVERAGE CONCENTRATIONS OF GROSS BETA EMITTERS, JANUARY - JUNE, 1963

[Detection Limit is 8×10^{-8} µc/cc at 95% C.L.]

Well (200-East Area, Prefixed by 299)	Concentration (Units of 10^{-8} µc/cc)	Well	Concentration (Units of 10^{-8} µc/cc)
E28-1	11	E13-6	< 8
E28-2	25	E25-2	200
E28-3	< 8	E24-1	95,000
E24-4	10	E25-3	700
E28-5	43	E25-4	150
E28-6	< 8	E24-4	125
E27-1	4,300	E24-5	490
E23-1	< 8	E17-1	130,000
E28-7	15	E24-2	260,000
E26-1	8	E25-1	170
E33-16	8,300	E33-19	2,400
E33-15	16,500	E33-20	3,100
E33-12	9,200	E13-7	< 8
E33-17	22,000	E13-8	< 8
E33-13	2,000	E13-9	< 8
E33-14	3,700	E13-10	< 8
E33-11	5,800	E13-11	< 8
E33-9	4,200	E13-12	< 8
E33-8	200	E13-13	< 8
E33-1	3,000	E13-14	< 8
E33-2	800	E24-7	12
E33-3	7,000	E25-5	80
E33-4	3,000	E25-6	420
E33-7	150	E25-9	97
E33-10	< 8	E24-3	15
E33-6	200	E13-16	< 8
E33-5	550	E25-7	1,400
E33-18	1,400	E25-8	1,200
E13-1	< 8	E13-15	< 8
E13-2	< 8	E13-17	< 8
E13-3	< 8	E13-18	< 8
E13-4	< 8	E13-19	< 8
E13-5	< 8	E33-21	< 8

VI. APPENDIX (contd.)

TABLE III (contd.)

Well	Concentration (Units of 10^{-8} µc/cc)	Well	Concentration (Units of 10^{-8} µc/cc)
200-East Area (prefixed by 299)			
E24-8	510	E24-9	9,600
E28-8	< 8	E17-2	15,600
E28-9	< 8	E17-3	61,000
E32-1	< 8	E26-6	3,500
E19-1	< 8	E25-11	480
E26-5	100	E25-12	850
E13-20	< 8	E16-2	220
E26-4	90	E16-1	240
E26-2	15	E28-10	20
E26-3	77	E23-2	14
E25-10	470	E34-1	< 8
E27-3	62	E27-5	180
		E28-11	10
200-West Area (Prefixed by 200)			
W11-1	< 8	W15-4	310
W11-2	23	W15-1	< 8
W11-3	< 8	W23-1	< 8
W11-4	< 8	W22-4	< 8
W11-5	< 8	W22-18	5,000
W11-6	< 8	W22-5	4,050
W11-7	< 8	W22-6	< 8
W11-8	< 8	W22-7	23
W11-9	8	W22-8	12
W11-10	< 8	W22-9	560
W12-1	< 8	W22-10	250
W10-3	68	W22-11	< 8
W10-4	92	W22-15	5,900
W11-11	180	W22-16	20
W11-12	80	W23-2	< 8
W14-1	16	W23-3	11
W10-5	8	W22-12	160,000
W15-2	< 8	W22-13	160,000
W10-1	< 8	W22-14	270,000
W10-2	not sampled	W26-3	120
W15-3	59	W22-17	140
W14-2	325	W22-1	240
W22-2	450	W18-2	14
W15-5	< 8	W18-5	< 8
W19-1	< 8	W15-6	< 8
W22-19	6,500	W18-1	8

VI. APPENDIX (contd.)

TABLE III (contd.)

Well	Concentration (Units of 10^{-8} µc/cc)	Well	Concentration (Units of 10^{-8} µc/cc)
200-West Area (Prefixed by 299)			
W23-4	34	W18-3	not sampled
W22-20	205	W18-4	< 8
W6-1	< 8	W19-4	< 8
W19-2	28	W22-22	< 8
W19-3	35	W22-23	13
W21-1	8	W22-24	15
W22-21	16	W11-13	12
W11-14	< 8	W14-3	44
300 Area Wells (Prefixed by 399)			
3-2	not sampled	1-4	14
3-3	not sampled	8-2	< 8
3-1	18	6-1	< 8
2-1	31	4-1	20
1-1	20	5-1	< 8
1-2	22	8-3	< 8
8-1	< 8	4-7	18
1-3	22	5-2	< 8
600 Area Wells (Prefixed by 699)			
S27-E14	< 8	8-17	< 8
34-51	< 8	S7-34	< 8
25-55	< 8	10-54	< 8
24-33	125	12-64	< 8
19-43	< 8	40-24	10
20-20	24	40-33	< 8
35-9	< 8	54-42	< 8
8-32	< 8	47-60	< 8
S8-19	< 8	60-60	< 8
17-5	< 8	63-90	< 8
2-3	< 8	59-80B	8
S12-3	< 8	43-89	not sampled
S31-1	< 8	34-88	< 8
55-50A	12		

VI. APPENDIX (contd.)

TABLE III (contd.)

Well 600 Area (Prefixed by 699)	Concentration (Units of 10^{-8} μc/cc)	Well	Concentration (Units of 10^{-8} μc/cc)
25-80	< 8	48-71	< 8
35-70	< 8	51-63	< 8
55-70	< 8	71-30	< 8
49-79	< 8	32-72	< 8
39-79	< 8	32-70	12
35-78	< 8	38-70	8
32-77	< 8	35-66	< 8
36-61A	< 8	31-65	< 8
34-39A	360	51-75	< 8
45-69	< 8	50-85	< 8
45-42	< 8	63-25	< 8
50-30	< 8	77-36	< 8
25-70	< 8	62-43A	< 8
55-89	< 8	S6-E4B	< 8
71-52	10	S6-E4D	< 8
70-68	< 8	S6-E4E	< 8
40-62	< 8	S6-E4F	< 8
50-42	< 8	S6-E4G	< 8
68-38	< 8	S6-E4H	< 8
57-29	< 8	S6-E4J	< 8
15-26	19	78-62	< 8
72-88	< 8	77-54	< 8
65-72	11	1-18	< 8
54-57	< 8	83-47	< 8
62-32	< 8	74-44	< 8
31-30	245	42-12	< 8
49-48	< 8	26-15	22
50-53	6,250	9-E2	< 8
61-66	< 8	31-53B	< 8
51-18	< 8	28-52	< 8
65-50	< 8	19-88	< 8
47-35	< 8	33-56	10
45-20	< 8	HAN-9	< 8
38-43	< 8	24-46	< 8
28-40	< 8	2-33	< 8
55-50C	not sampled	24-40	< 8
49-57	< 8	19-58	< 8
42-42	< 8	20-82	< 8

VI. APPENDIX (contd.)

TABLE III (contd.)

Well	Concentration (Units of 10^{-8} µc/cc)	Well	Concentration (Units of 10^{-8} µc/cc)
600 Area (Prefixed by 699)			
17-47	< 8	57-83	< 8
17-70	< 8	20-39	< 8
65-59	< 8	69-45	< 8
55-76	< 8	67-51	< 8
55-95	< 8	49-55	< 8
S14-20	< 8	53-55	< 8
38-65	< 8	47-46	< 8
66-23	< 8	72-92	< 8
44-64	< 8	40-1	< 8
36-61B	< 8	20-E12	15
32-62	< 8	72-73	< 8
15-15	< 8	86-60	< 8
S11-E12	< 8	89-35	< 8
S3-E12	< 8	S18-E2	< 8
37-82A	12	43-104	not sampled
37-82B	< 8	54-37	not sampled
67-98	< 8	36-93	< 8
27-8	< 8	50-28	< 8
36-E14	< 8	10-E12	< 8
		74-60	16
3000 Area Wells (Prefixed by 3099)		71-77	150
		67-86	< 8
		66-38	< 8
45-16	15	74-48	< 8
49-16	< 8	97-43	< 8
		96-49	< 8
		S12-30	< 8
		3-45	< 8
		29-78	< 8
		22-70	< 8
		84-35	< 8
		81-58	< 8
		26-89	< 8
		64-27	< 8

VI. APPENDIX (contd.)

TABLE IV

AVERAGE TRITIUM CONCENTRATION IN WELL WATER SAMPLES, JANUARY - JUNE, 1963

[Detection limit is 1.0 x 10^{-5} µc/cc at 90% C.L.]

Well	Concentration (Units of 10^{-5} µc/cc)	Well	Concentration (Units of 10^{-5} µc/cc)
200-West Area (Prefixed by 299)			
W10-1	< 1	W19-2	190
W6-1	< 1	W22-14	21,000
W12-1	23	W22-19	2,250
W15-2	< 1	W23-4	8,400
W19-4	< 1	W21-1	140
		W22-2	74
200-East Area (Prefixed by 299)			
E32-1	< 1	E24-7	5
E24-1	3,800	E13-13	< 1
E25-3	220	E28-2	< 1
E25-7	180	E33-4	< 1
E19-1	< 1	E25-11	110
E24-2	4,200	E26-5	13
E17-1	6,200	E24-7	1
		E26-1	< 1
		E34-1	3
		E13-20	3
		E33-2	1
600 Area (Prefixed by 699)			
17-5	1	35-9	< 1
20-20	43		
20-E12	< 1	37-42	92
24-33	100	34-51	1
25-55	< 1	38-70	65
25-70	5	40-1	1
27-8	2	40-24	7
30-31	445	40-33	< 1

VI. APPENDIX (contd.)

TABLE IV (contd.)

Well 600 Area (Prefixed by 699)	Concentration (Units of 10^{-5} μc/cc)	Well	Concentration (Units of 10^{-5} μc/cc)
		42-42	115
34-39A	300	45-20	< 1
45-69	< 1	50-42	< 1
2-3	< 1	51-75	< 1
8-17	< 1	53-55	< 1
8-32	< 1	54-42	< 1
		28-40	3
15-26	58		
47-35	< 1	19-43	< 1
48-71	1	54-57	< 1
49-55	< 1		
49-79	< 1	55-50A	< 1
50-28	< 1		
50-30	< 1		
50-53	4		
10-E12	< 1		
S6-E14	< 1		
S3-E12	< 1	9-E2	< 1
		50-85	< 1