EARTH SCIENCES WASTE
DISPOSAL INVESTIGATIONS
JANUARY - JUNE, 1967

J. R. Eliason

DECEMBER 27, 1967

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EARTH SCIENCES WASTE DISPOSAL INVESTIGATIONS -- JANUARY - JUNE, 1967

by

J. R. Eliason

Hydrogeology Research Unit
Water and Land Resources Section

December 27, 1967

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EARTH SCIENCES WASTE DISPOSAL INVESTIGATIONS

JANUARY - June, 1967

INTRODUCTION

The Hanford Project has over 500 wells which are used for the surveillance of radionuclides in the ground that results from waste disposal. Wells are located at disposal sites to monitor the migration of radionuclides in the soil and to determine when a disposal facility is to be abandoned. Outside of the immediate disposal areas, wells are sampled to determine the movement of contaminants in the ground water zone. The movement of wastes in unconfined ground water aquifers is followed by routine sampling, and the confined aquifers in the area are sampled frequently where possible.

This report is prepared semi-annually to give an evaluation of ground water contamination that results from disposal of plant effluents. All ground water samples were collected by the Environmental Studies Section and analyzed by the Radiological Analysis Unit. The data present in this report were collected during the first six months of 1967; the preceding report in this series is BNWL-432⁽¹⁾.

Analytical results for gross beta activity in the unconfined and confined ground water aquifers are presented in Tables A and B respectively. Results are given where concentrations of radionuclides are above the routine detection limit of 0.08 pCi β /cc. The average concentrations detected during the previous report period are listed for comparison. The locations of wells referred to in this report may be found by consulting the well-location maps published in the latest Hanford Wells document.

EVALUATION OF GROUND WATER MONITORING DATA

Ground water samples are analyzed routinely for gross beta; this is generally calculated as $^{106}\text{Ru} - ^{106}\text{Rh}$ because isotopic analyses have shown that $^{106}\text{Ru} - ^{106}\text{Rh}$ is the primary beta-emitter in the ground water. Other analyses are made at specific sites for gross alpha, ^3H , ^{90}Sr , ^{137}Cs , and other isotopes of particular interest. The gross beta and tritium results are plotted on water table contour maps, and iso-concentration lines drawn to show the two-dimensional extent and direction of contamination spread. Figure 1 shows the extent of ground water gross beta contamination, and Figure 2 shows the extent of ground water tritium contamination as of June 30, 1967.

200 East Area

Gross beta concentrations in the ground beneath the 200 East Area have shown no significant change during this report period (see Table A). Analyses were made for specific isotopes beneath some inactive and all of the major active disposal sites (Table 1). Concentrations of ^{90}Sr , ^{137}Cs , and total α did not exceed the routine detection limits during this report period. Samples from several disposal sites (listed in Table I) were above the analytical detection limits for ^{90}Sr and ^{137}Cs when calculated at the 95 percent confidence level*. Low concentrations of ^{60}Co were detected in the ground water at the 216-A-10 (0.2 pCi $^{60}\text{Co}/\text{cc}$), 216-A-36B (0.4 pCi $^{60}\text{Co}/\text{cc}$) and 216-B-7 (1.3 pCi $^{60}\text{Co}/\text{cc}$) disposal sites. The maximum six month average gross beta concentration was detected at the 216-A-36B crib site (61.8 pCi/cc).

* Improved counting techniques have resulted in frequent positive analytical reports on isotopic analyses which would have previously been reported as less than detectable based on routine limits. This is not to be construed as the sudden appearance of very low levels of radionuclides at these specific monitoring sites, but rather a change in reporting procedure.

Tritium concentrations in the ground water beneath 200 East Area have shown only minor changes during this report period.

200 West Area

Minor changes in beta concentrations beneath 200 West Area were observed during this report period. Gross beta activity at the 216-S-9 crib site continued to increase from 41,000 pCi/cc, July-December 1966, to 74,000 pCi/cc this report period in well 299-W22-26. Gross beta activities in 200 West Area wells are tabulated in Table A.

Low but detectable concentrations of long-lived isotopes were reported at several 200 West Area disposal sites. The highest ^{90}Sr concentration reported was at the abandoned 216-S-1 & 2 cribs, 92 pCi/cc. Total alpha was reported at or above the 0.02 pCi/cc detection limit at the 216-S-9, 216-S-21, 216-U-1 & 2, and 216-Z-7 crib sites (Table I). Cesium-137 was detected in the ground water above the 0.6 pCi/cc detection limit at the 216-S-9 (0.9 pCi ^{137}Cs /cc) crib site. Samples from several disposal sites, listed in Table I, were at or above the analytical detection limits for ^{90}Sr , ^{137}Cs , and total alpha (when calculated at the 95 percent confidence level). Cobalt-60 was detected in ground water beneath the 216-S-9 (38 pCi ^{60}Co /cc) and 216-T-27 (3.2 pCi ^{60}Co /cc) cribs. The maximum total beta (74,000 pCi/cc) concentration in the ground water beneath 200 West Area was detected near the 216-S-9 crib.

The 300 Area waste, as of March 13, 1967, was being disposed to the 216-T-35 crib which replaced the 216-T-34 crib. Tritium concentrations in the ground water beneath 200 West Area have shown only minor changes during this report period.

TABLE I

Activity in the Ground Water at Major Disposal Sites
From the Wells Having the Highest Activity Level at Each Site¹

Crib	Waste	Average Concentrations, January-June, 1967			
		pCi _β /cc	pCi _α /cc	pCi ⁹⁰ Sr/cc	pCi ¹³⁷ Cs/cc
<u>Purex</u>					
216-A-8	Tank Farm Condensate	1.3	<0.02	<0.03*	<0.6
216-A-9	Acid Fractionator & 100-N	8.3	<0.02	<0.03*	<0.6*
216-A-10	Process Condensate	58.5	<0.02	<0.03*	<0.6*
216-A-27	Laboratory & Floor Drains	13.4	<0.02	<0.03	<0.6*
216-A-31	Organic Waste	50.9	<0.02	<0.03*	<0.6*
216-A-36B	Scrubber Waste	61.8	<0.02	<0.03*	<0.6*
<u>B-Plant</u>					
216-B-7	Decontamination	1.8	<0.02	<0.03*	<0.6*
216-B-50	ITS and Tank Farm Cond.	20.5	----	<0.03*	---
<u>C-Plant</u>					
216-C-10	Process Condensate	0.5	<0.02	<0.03*	<0.6*
<u>Redox</u>					
216-S-6	Steam Condensate	6.8	<0.02	<0.03	<0.6
216-S-9	Process Wastes	74,400.	0.02	<0.03*	0.9
216-S-13	Wastes Containing Hexone	0.6	<0.02	----	---
216-S-20	Laboratory Wastes	2.3	<0.02*	<0.03*	<0.6*
216-S-21	Tank Farm Condensate	2.5	0.12	<0.03*	<0.6*
<u>T-Plant</u>					
216-T-19	Process Condensate	11.7	----	<0.03	<0.6
216-T-27	Decontamination	662.0	<0.02	<0.03*	<0.6*
216-T-34	300 Area Lab. (abandoned)	6.7	<0.02	<0.03*	<0.6*
216-T-35	300 Area Lab. (new)	23.2	<0.02	<0.03*	<0.6*
<u>U-Plant</u>					
216-U-1&2	Decontamination & Cell Drain	5.4	0.06	<0.03	<0.6*
216-U-12	Process Condensate	0.6	<0.02	----	---
<u>Z-Plant</u>					
216-Z-1A	Recovery Process Waste	8.9	<0.02	----	---
216-Z-7	Floor Drains	8390.	0.03	<0.03*	<0.6*
216-Z-12	Neutralized Process Wastes	4.4	<0.02	<0.03	<0.6*

¹A blank in the table indicates that the particular analysis was not made on samples from the site.

*Concentrations were above the analytical detection limits when calculated at the

Separations Disposal Sites

The concentrations of radioisotopes in the ground water at major disposal sites are listed in Table I. Minor cribs and french drains are not included in the table. The concentrations listed for each site are those noted in samples from the well(s) that showed the highest concentration.

600 Area (Hanford Project Outside of Exclusion Areas) Beta Contamination

Beta concentrations detected in the 600 Area wells are tabulated in Table A, and the distribution of gross beta activity in the ground water is shown in Figure 1.

Only minor changes in the beta contamination pattern have been detected in the past six months. An area near Gable Butte has been included in the 0.08-1 pCi/cc beta contamination zone, and an area near the 216-T-34 crib in 200 West area, that was shown previously as >100 pCi/cc, is now in the 1-100 pCi/cc zone. The 1-100 pCi/cc zone moving from 200 West Area has been enlarged to include wells showing increased activity. The maximum six month average beta activity detected in the 600 Area wells was 5.9 pCi/cc in well 699-30-31.

600 Area (Hanford Project Outside of Exclusion Areas) Tritium Contamination

The distribution of tritium in the ground water is shown in Figure 2. The general tritium concentration patterns have not changed significantly. Several wells in 200 East Area showed decreases in tritium activity which reduced the extent of the 100-1000 pCi/cc and >1000 pCi/cc zones. Wells in 200 West area showed increases in tritium activity which accounts for the larger 100-1000 pCi/cc and >1000 pCi/cc zones. The general pattern of the 10-100 pCi/cc and 100-1000 pCi/cc zones south of the 200 East area has changed slightly due to a decrease in tritium activity detected in several wells in that area.

Figure 1

Extent of Ground Water Gross Beta Contamination, January-June, 1967

Figure 2

Extent of Ground Water Tritium Contamination, January-June, 1967

CONTAMINATION IN CONFINED AQUIFERS

Beta emitter concentrations detected in samples taken at various depths, and in some instances from confined aquifers, below the water table are listed in Table B.

Depth sampling in wells and samples taken from specific aquifers over the past years indicate that some radioactive materials are entering the confined aquifers beneath the project. The extent of waste spread in confined aquifers is difficult to evaluate because of the limited number of points at which they can be sampled. The maximum six month average beta activity reported in a confined zone was 1.25 pCi/cc in well 699-30-31R in a zone 333 feet below the water table. The maximum average tritium activity detected in a confined zone was 2200 pCi/cc at the same location (well 699-30-31R). Samples collected from wells 699-14-E6 P, Q, R, S, T; 699-20E-5 P, Q, R, S, T; and 699-24-1 P, Q, R, S which intercept confined aquifers near the river have not shown beta activity above the 0.08 pCi/cc detection limit.

GROUND WATER TEMPERATURE SURVEY

An isothermal map of the ground-water surface, made from data collected in May, 1967, is shown in Figure 3. The temperature patterns that have developed show the influence of the disposal of heated wastes and coolant water from the separations facilities. The general temperature gradients near the 200 Areas correspond reasonably well with the contamination patterns observed in the ground water. The maximum ground water temperature was 42°C in 200 East Area and 30°C in 200 West Area.

GROUND WATER QUALITY

The disposal of wastes to the ground has caused measurable changes in ground water quality near disposal sites. The changes in water quality are attributable directly to the concentrations of salts in the wastes and indirectly to the degradation of minerals in the soil by the wastes. Table II shows concentrations of radioactive and non-radioactive materials in the ground water near disposal sites and down-gradient from the sites. Concentrations of the non-radioactive materials in the ground water are below the Public Health Service recommended drinking water limits except for nitrate which is above the recommended 45 ppm limit in several wells.

WELL DRILLING

Wells have been drilled around several disposal sites in the 200 areas to obtain data needed for the inventory of activity above the ground water table in connection with Ben Franklin Dam Studies. Many of these wells will be available later for ground water monitoring purposes. Two monitoring wells, 299-E17-8 and 299-E24-11, were drilled during this report period near the new 216-A-38 crib which is a backup for the 216-A-10 crib.

TABLE II

Ground Water Quality -- January - June, 1967

Well No.	Miles From Processing Facility	Total β pCi/cc	Total α pCi/cc	pH	$\text{SO}_4^{=}$ ppm	NO_3^- ppm	Na^+ ppm	Ca^{++} ppm	Organic ppm
<u>200 East</u>									
299-E17-1	<1	32.9	<0.02	7.5	30.0	86	37	34	0.1
299-E17-2	<1	13.6	<0.02	7.3	41.0	93	37	38	<0.1
299-E17-5	<1	61.8	<0.02	7.5	50.0	129	43	89.1	<0.1
299-E24-2	<1	58.5	<0.02	7.5	34.5	200	40	253	0.2
299-E24-9	<1	50.9	<0.02	7.5	39.0	171	37	68	0.1
<u>600 Area</u>									
699-36-46R	<1	0.68	<0.02	7.4	13.6	N.D.	3	13	0.4
699-34-39A	2.0	4.4	<0.02	7.5	41.5	43	34	28	<0.1
699-28-40	2.6	0.75	<0.02	7.3	3.3	5	30	4	0.1
699-40-33	3.0	<0.08	<0.02	7.9	1.3	0.5	54	9	0.1
699-30-31	3.8	5.9	<0.02	7.7	38.5	28	33	16	0.1
699-24-33	4.0	1.2	<0.02	7.7	41.0	25	24	22	<0.1
699-41-23	4.9	0.6	<0.02	7.7	44.0	18	39	26	<0.1
699-15-26	6.1	1.54	<0.02	7.4	41.0	31	22	31	<0.1
699-20-20	6.4	0.3	<0.02	7.6	44.5	41	18	39	<0.1
699-26-15	6.9	2.9	<0.02	7.8	33.5	40	25	31	<0.1
Average Concentrations in Columbia River at Hanford, February - May, 1967					16.0	0.5		25	
Average Concentrations in Ground Water Prior to Significant Plant Disposal (2)				7.9	21.5	2.2	19.4	28.8	

REFERENCES

1. J. R. Eliason. Earth Sciences Waste Disposal Investigations, July-December, 1966, BNWL-432. June 14, 1967.
2. R. C. Newcomb and J. R. Strand. Geology and Ground Water Characteristics of the Hanford Reservation of the Atomic Energy Commission, Washington, USGS-W-P-8. December, 1953.

TABLE AGross Beta Activity in Unconfined Ground Water

Well Designation	January - June, 1967			July-Dec., 1966
	Avg. Conc. pCi β /cc	Max. Conc. pCi β /cc	Conc. In Latest Sample pCi β /cc	Avg. Conc. pCi β /cc
<u>200 East Area</u>				
<u>Wells Monitoring 216-A</u>				
<u>Disposal Facilities</u>				
299-E16-2	0.17	0.23	0.13	1.3
299-E17-1	32.9	40.2	22	49.1
299-E17-2	13.6	23.2	15	13.9
299-E17-3	25.3	35.0	19.7	29.5
299-E17-4	54.5	84.3	36.6	5.0
299-E17-5	61.8	82.7	69.6	78.9
299-E17-6	0.78	3.0	0.4	73.7
299-E24-2	58.5	89.4	53.1	90.8
299-E24-3	8.3	54.8	0.4	1.6
299-E24-4	7.5	47.8	0.4	0.8
299-E24-9	50.9	111.0	39.9	40.2
299-E25-2	4.8	22.1	0.9	1.5
299-E25-3	32.4	181.0	0.4	2.3
299-E25-4	1.3	12.7	<0.08	0.21
299-E25-5	2.4	6.7	1.6	1.1
299-E25-6	2.9	9.1	9.1	1.3
299-E25-7	2.0	7.1	7.1	1.8
299-E25-11	1.6	11.1	0.4	0.91
299-E25-12	0.4	1.4	0.14	1.8
299-E26-4	5.5	35.5	2.3	9.7

Wells Monitoring 216-B
Disposal Facilities

299-E27-5	0.5	1.2	0.2	0.9
299-E33-3	20.5	28.6	8.7	20.9
299-E33-18	1.8	5.1	1.7	2.4

Wells Monitoring 216-BC
Disposal Facilities

299-E13-20	0.34	1.0	<0.08	22.8
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TABLE A. (Continued)

				July-December 1966
Well Designation	Avg. Conc. pCi/g/cc	Max. Conc. pCi/g/cc	Conc. In Latest Sample pCi/g/cc	Avg. Conc. pCi/g/cc
<u>Wells Monitoring 200 East Area</u>				
<u>Outside Specific Disposal Sites</u>				
299-E19-1	0.09	0.2	<0.08	1.8
299-E24-7	0.2	0.9	<0.08	0.8
299-E28-4	0.2	0.61	<0.08	0.4
<u>200 West Area</u>				
<u>Wells Monitoring 216-S</u>				
<u>Disposal Facilities</u>				
299-W22-1	308.0	432.0	274.0	350.0
299-W22-14	16.6	23.7	--	123.0
299-W22-19	11.7	69.5	2.8	3.2
299-W22-20	2.3	10.1	1.1	3.6
299-W22-21	4.8	25.6	0.2	0.19
299-W22-25	22,700.	41,000.	4,370.	2,600.
299-W22-26	74,500.	93,000.	74,000.	41,000.
299-W22-27	418.	539.	511.	340.
299-W23-2	0.54	1.9	0.16	0.35
299-W23-3	0.7	3.3	0.4	0.23
299-W23-4	2.4	8.5	0.9	79.
<u>Wells Monitoring 216-U</u>				
<u>Disposal Facilities</u>				
299-W19-3	5.4	15.0	2.7	0.22
299-W21-1	0.1	0.25	<0.08	2.4
299-W22-22	0.6	3.4	<0.08	1.0
<u>Wells Monitoring 216-T</u>				
<u>Disposal Facilities</u>				
299-W6-1	0.2	0.41	0.08	0.68
299-W11-15	6.7	8.5	7.1	4.5
299-W11-16	1.1	3.8	3.8	31.6
299-W12-1	0.13	0.47	<0.08	1.1
299-W14-1	310.	587.	145.	510.
299-W14-2	4,440.	6,370.	4,170.	11,000.
299-W14-3	662.	849.	380.	832.

TABLE A. (Continued)

				July-December 1966
Well Designation	Avg. Conc. pCiβ/cc	Max. Conc. pCiβ/cc	Conc. In Latest Sample pCiβ/cc	Avg. Conc. pCiβ/cc
Wells Monitoring 216-Z				
<u>Disposal Facilities</u>				
299-W15-7	8,390.	21,800.	21,800.	9,000.
299-W18-1	0.5	1.2	0.16	27.3
299-W18-5	4.4	16.1	5.5	2.2
600 Area Wells				
699-S12-29	0.16	0.5	0.12	0.12
699-S8-19	0.24	0.82	0.82	5.8
699-S6-E14	0.1	0.16	0.13	0.47
699-S3-E12	0.17	0.69	<0.08	2.1
699-8-17	0.23	1.0	<0.08	<0.08
699-10-E12	0.7	3.2	0.09	0.26
699-14-E6T	0.4	0.6	0.2	0.5
699-16-26	1.5	2.2	1.3	1.3
699-19-58	0.4	1.5	0.1	1.6
699-20-E5T	0.38	0.8	0.24	1.3
699-20-20	0.3	0.74	0.2	0.18
699-24-33	1.2	3.0	3.0	1.2
699-26-15	2.9	3.3	3.3	2.2
699-27-8	0.08	0.18	0.12	0.14
699-28-40	0.75	1.3	0.9	0.47
699-29-78	0.38	0.91	0.16	0.18
699-30-31	5.9	19.1	4.2	4.5
699-31-53B	0.33	1.3	0.08	0.83
699-31-65	0.34	1.3	<0.08	0.08
699-32-62	1.14	4.9	0.25	0.13
699-33-56	<0.07	0.16	<0.08	<0.08
699-34-39A	4.4	6.6	1.9	7.03
699-34-88	3.8	12.2	12.2	0.19
699-35-70	0.32	0.63	0.18	1.3
699-36-46R	0.68	1.36	1.12	0.3
699-38-65	0.17	0.24	<0.08	0.13
699-38-70	0.09	0.15	<0.08	<.08
699-40-1	<0.08	0.18	<0.08	0.08
699-41-23	0.6	0.8	0.8	0.47
699-42-42	2.5	12.3	0.17	0.45
699-44-64	0.08	0.28	<0.08	0.35
699-45-69	<0.08	0.08	<0.08	0.12
699-47-35	0.11	0.25	0.1	0.11

TABLE A. (Continued)

Well Designation	Avg. Conc. pCi β /cc	Max. Conc. pCi β /cc	<u>July-December 1966</u>	
			Conc. In Latest Sample pCi β /cc	Avg. Conc. pCi β /cc
699-47-46	0.43	6.9	0.08	0.12
699-50-53	3.5	7.5	2.5	5.7
699-50-85	0.23	0.46	0.1	1.0
699-53-55	0.43	1.7	0.12	2.7
699-54-57	<0.08	0.14	<0.08	0.20
699-55-50A	1.43	5.8	0.30	0.37
699-55-76	0.08	0.13	<0.08	0.09
699-55-89	<0.08	0.14	<0.08	0.29

Other wells were sampled and found to be below the routine detection limit of 0.08 pCi β /cc.

TABLE B

Gross Beta Activity in Confined Ground Water

Piezometer Tube Designation	Depth Below Water Table (feet)	<u>January - June, 1967</u>			<u>July-Dec., 1966</u>
		Avg. Conc. pCi β /cc	Max. Conc. pCi β /cc	Conc. In Latest Sample pCi β /cc	Avg. Conc. pCi β /cc

600 Area

699-S31-1P	141	0.38	0.88	0.3	0.14
699-S18-E2P	168	0.6	1.6	0.4	0.08
699-S14-20P	74	0.6	2.3	0.35	0.158
699-S12-29P	84	0.35	0.56	0.35	0.30
699-S6-E4CP	377	0.17	0.24	<0.08	0.40
699-10-E12P	283	0.23	0.58	0.12	0.35
699-20-E12P	260	0.22	0.36	0.15	0.48
699-28-40P	313	0.35	0.89	<0.08	1.82
699-30-31P	503	0.23	0.63	<0.08	0.14
699-30-31R	333	1.25	1.37	1.2	0.70
699-42-42P	106	0.20	0.4	0.09	0.18
699-55-50AP	55	0.83	1.7	<0.08	0.75

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