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CHEMICAL EFFLUENTS TECHNOLOGY WASTE DISPOSAL INVESTIGATIONS
JANUARY - JUNE 1965

By

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PACIFIC NORTHWEST LABORATORY
RICHLAND, WASHINGTON
operated by
BATTELLE MEMORIAL INSTITUTE
for the
UNITED STATES ATOMIC ENERGY COMMISSION UNDER CONTRACT AT(45-1)-1830

54-1100-057 (6-65)
AEC-RLOO RICHLAND, WASH.

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CHEMICAL EFFLUENTS TECHNOLOGY WASTE DISPOSAL INVESTIGATIONS JANUARY - JUNE 1965

I. INTRODUCTION

The continual surveillance of radionuclides in the ground beneath the Hanford Project is conducted under a radiological monitoring program defined by Chemical Effluents Technology. A network of over 500 cased wells exists on the Project for monitoring underground waste disposal sites and for tracing the movement of radionuclides released to the surface and subsurface environs.

A report is prepared semiannually to present information on the status of ground water contamination. Maps, which are included in the reports, define contaminated ground water zones with respect to the disposal areas and the Project in general. This report presents a summary and interpretation of the ground water monitoring data collected during the first six months of 1965. For reference, the preceding report in this series is HW-84549.

In the Appendix, those wells are shown in which concentrations of radionuclides were detected in the ground water above the routine detection limit of 0.08 pcB/cc. In addition to these data, the 1964 average concentrations of beta-gamma emitters in well water samples, for the wells listed in the Appendix, are also given for the purpose of indicating the general trend in ground water contamination. Analytical results (gross beta) of water samples collected from confined aquifers and the results of special tritium analyses are also presented in tables in the Appendix.

All ground water samples were collected by the Environmental Monitoring Unit and analyzed by the Radiological Chemical Analyses Unit.

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. In the 600 Area (the land within the Hanford fenced area, but outside the plant restricted areas) the second and third groups of numbers signify 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. The exact location of any well mentioned in this report can be located by referring to the well location maps published in the latest Hanford Wells document[1].

II. INTERPRETATION OF GROUND WATER MONITORING DATA

Analytical results of ground water samples are studied to determine which wells have concentrations of radioisotopes above the routine detection limit of 0.08 pcB/cc. The positive results are then checked for mathematical errors and the possibility of cross contamination during sampling and/or during the analysis. After this preliminary examination, the results are plotted on a contour map of the water table. Isoconcentration lines are then drawn to show the extent and direction of contamination spread. Figure 1 is a map showing the distribution of gross beta emitters in the ground water as of June 30, 1965. A comparison of the ground water contamination pattern in Figure 1 with that determined for the previous report period[2] shows several areas where the zones of contamination have changed. These changes are discussed below.

200-East Area

Total beta concentrations in the ground water beneath the disposal areas in and adjacent to 200-East Area are given in Table I of the Appendix.

Ground water samples from beneath all active and some inactive disposal sites in 200-East Area were analyzed for specific long-lived isotopes during this report period. The results show Co^{60} is still present in the ground water immediately surrounding the abandoned 216-BY crib site; however, the concentrations observed in these wells are gradually decreasing with time. The latest results show the maximum Co^{60} concentration beneath this general area to be 10 pc/cc, approximately one third the value reported in the previous summary. Sr^{90} was detected in the ground water beneath the 216-A-10, 216-A-24, and the 216-BC cribs during this report period in concentrations just above the routine detection limit of 0.01 pc/cc. Detectable concentrations of Cs^{137} were also observed in the ground water beneath the 216-A-24 crib. The maximum concentration, 7 pc Cs^{137}/cc, is about a factor of three below the recommended ground water limit of 20 pc/cc.

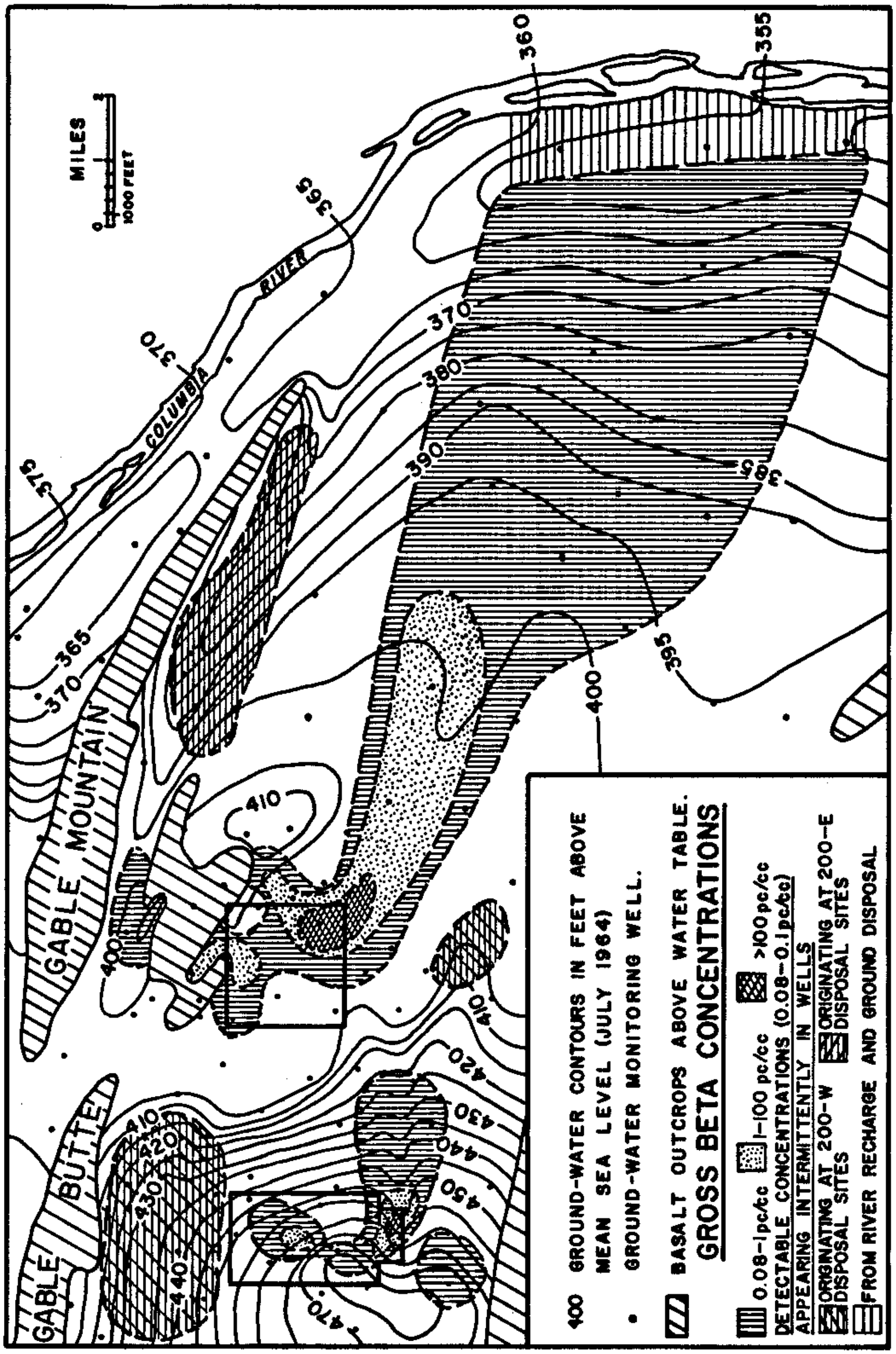

FIGURE 1.

Extent Of Ground Water Gross Beta Contamination, January - June 1965

The presence of both strontium and cesium in the ground water beneath the 216-A-24 crib indicates that the soil column underlying at least a portion of this crib may be approaching breakthrough. This crib is approximately 1,600 feet long and is divided into four sections. Because of the unusually low flow rate to this crib during the past five years (one-thirtieth the designed flow rate) most of the waste liquid discharged to the crib is infiltrating into the ground through only the first of the four sections. The originally estimated crib life was five column volumes. Approximately 4.5 column volumes have been discharged to this crib to date; however, this value is based on the use of all four sections of the crib. It appears that the first section of the crib has probably exceeded the 5 column volumes with the appearance of detectable concentrations of Sr and Cs in the ground water. The Chemical Processing Department has been apprised of the situation and is making a study to determine the feasibility of by-passing the first or the first two sections of this crib and utilizing those portions which have had little or no use.

The sampling frequencies were increased for all wells monitoring the above-mentioned disposal sites where long-lived isotopes have been detected in the ground water.

<u>200-West</u>

Beta-emitter concentrations in the ground water beneath 200-West Area are listed in Table I. These results show no appreciable changes in the concentration levels during the past six months. The extent of contaminated ground water spread from beneath 200-West disposal sites is slightly larger than that shown on the map in the previous report. Several monitoring wells, located east of the 200-West Area, are now above the routine detection limit, and new monitoring wells drilled within the area are also showing detectable concentrations of beta emitters in the ground water. Consequently, the zone of lowest detectable contamination, 0.08-1 pc/cc, was extended to the east of the area and encompasses the three major disposal areas within the 200-West perimeter fence, i.e., Redox plant, T plant and Z plant.

Isotopic analyses of the ground water underlying several disposal sites in 200-West Area showed the presence of several long-lived radionuclides. Beneath the abandoned 216-S-1 and 2 cribs, Sr^{90} is still detectable in concentrations averaging 14 pc/cc. This concentration, however, represents a decrease to one-fourth the value reported in the previous summary. The maximum concentration of 33 pc/cc also represents a decrease from the former values reported. It now appears that very little waste is draining into the ground water from this abandoned disposal site and that the trend to lower concentrations will continue. Low but detectable concentrations of Sr^{90} have persisted in the ground water beneath the 216-S-7 crib. Although the Sr^{90} concentrations are well below the recommended ground water limit it was recommended to the Chemical Processing Department that the replacement crib, 216-S-9, constructed about one year ago, be activated. During June, 1965, one ground water sample from beneath the 216-S-7 crib showed detectable concentrations of Cs^{137}. The routine detection limit for this isotope is 0.25 pc/cc. The concentration observed in the sample was 0.95 pc/cc. This result was confirmed by the analytical laboratory. At the time these data were received, action had already been taken to remove the crib from service. Alpha emitters were detected intermittently in the ground water beneath the 216-Z-12 crib during this report period. The concentration level is still too low to accurately determine what isotope is present. A study is continuing to determine the mechanism by which either plutonium or americium can move through the soil without appreciable sorption.

600-Area

Analytical results for all 600 Area wells showing detectable concentrations of beta emitters in the ground water are listed in Table I of the Appendix. No significant changes are noted in the extent of this contamination pattern over that reported six months ago.

Large volume ground-water samples, obtained from three wells located from two to seven miles southeast of 200-East Area, were given special analytical processing to define the isotopes contributing to routine gross beta activity determinations. Results showed that essentially all of the activity was attributable to Ru^{106}-Rh^{106} and tritium. Technetium-99, probably as an anion, was detected in all original and duplicate samples. The maximum concentration of Tc^{99} noted was 0.3 pc/cc (168 hour MPC_w is 3,000 pc/cc). At a distance of about seven miles from the Purex plant the Tc^{99} concentration is about equal to the Ru^{106} concentration. The presence of Tc^{99} will have the effect of increasing slightly the total beta concentrations reported previously for the region near the Columbia River (which are now calculated on the basis of Ru^{106}) due to the greater counting efficiency factor for Ru^{106}, which is approximately twice that of Tc^{99}.

The concentration of beta emitters in the ground water beneath the Gable Mountain swamp is now slightly above the routine detection limit. There has been a gradual decrease in radioactivity in the ground water beneath this site for the past nine months. Wells located southeast of the Gable Mountain swamp continue to show intermittent concentrations of beta emitters in the ground water. The source of this activity is probably the Gable Mountain swamp contamination incident of June, 1964.

Isotopic analyses of ground water samples obtained from wells located in the ground water trough paralleling the Columbia River continue to show detectable concentrations of both Ru^{106} and Cr^{51}, indicating a mixing of river water and ground water.

III. FISSION PRODUCT TRITIUM IN THE GROUND WATER

Figure 2 is a map showing the latest two-dimensional distribution of tritium in the ground water beneath Hanford. The zones of tritium contamination are defined on this map by ranges of selected average concentration values. The general pattern of contamination is similar to that shown in Figure 1 for beta emitters in the ground water. The significant difference between these two maps is the forking of the main contaminated ground water plume approximately midway between the 200-East area and the Columbia River. The beta map shows a rather sharp swing to the south and then eastward to the river. Apparently there are several permeable channels within the Ringold Formation in this general region which influence the direction of ground water movement. Those wells located between the river and the southern fork of contaminated ground water have shown detectable concentrations of tritium in the past. The absence of tritium in these wells during this report period probably reflects fluctuations in disposal rates to ground in years past. This forking of the main contaminated ground water plume was first observed and mapped in June, 1962[3].

Ground water samples from confined aquifers at depth show the presence of tritium. The maximum result, 2,300 pc/cc, was observed in well 699-30-31 at a depth of 300 feet below the regional water table. This well is located three miles southeast of the 200-East area and approximately nine miles from the Columbia River. The maximum result reported in the previous summary was also noted in this well, 200 pc/cc at the 500 foot depth.

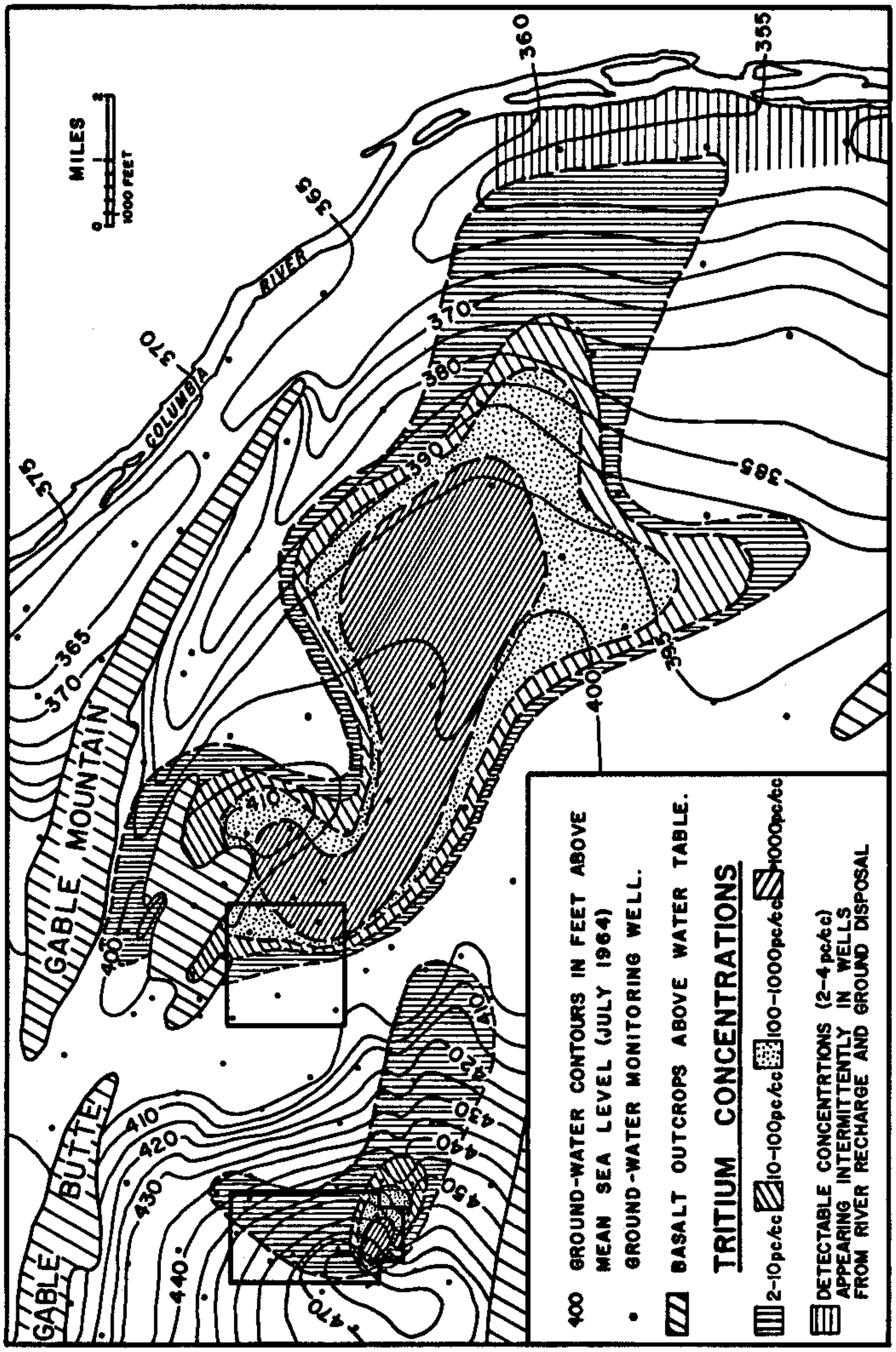

FIGURE 2.

Extent Of Ground Water Tritium Contamination, January - June 1965

IV. WELL DRILLING

Funds were approved for the construction of 23 new monitoring wells in the region southeast of 200-East area. These wells will provide monitoring access to all of the confined aquifers believed to be potentially contaminated. It is anticipated that these wells will also assist in defining the flow pattern of contaminated ground water from the disposal sites into the confined aquifers located beneath 200-East area.

Nine additional monitoring wells have been completed and are now in use within the Separations Areas. Six of these wells are located near recently completed disposal facilities in the 200-West area and three are adjacent to a new disposal facility now being constructed south of the Purex plant.

V. REFERENCES

1. D. J. Brown and V. L. McGhan. Hanford Wells, HW-44355 Rev. 2. January, 1963.
2. D. J. Brown. Chemical Effluents Technology Waste Disposal Investigations, January-December, 1964, HW-84549. December 31, 1964.
3. D. J. Brown. Chemical Effluents Technology Waste Disposal Investigations, January-June, 1962, HW-74915 RD. September 10, 1962.

VI. APPENDIX

RADIOLOGICAL MONITORING DATA FROM GROUND WATER SAMPLES, JANUARY-JUNE, 1965
GROSS BETA ACTIVITY

Well Designation	Unconfined Ground Water Aquifer Avg. Conc. pcB/cc	Max Conc. pcB/cc	Conc. In Latest Sample pcB/cc	Avg. Conc. 1964 pcB/cc
200-East Area				
Wells Monitoring 216-A Disposal Facilities				
299-E16-1	2.1	2.1	2.1	.96
299-E16-2	.31	.46	.46	.37
299-E17-1	460.	550.	540.	1,500.
299-E17-2	88.	120.	120.	420.
299-E17-3	220.	560.	86.	460.
299-E24-1	150.	260.	140.	560.
299-E24-2	310.	560.	250.	1,800.
299-E24-9	270.	330.	240.	950.
299-E25-11	.92	1.2	.80	.86
299-E25-12	.66	.87	.58	1.2
299-E26-2	7.2	7.7	7.3	3.7
299-E26-3	8.8	9.5	7.1	9.2
299-E26-4	6.7	8.7	8.7	4.5
299-E26-5	1.6	1.6	1.6	1.1
Wells Monitoring 216-C Disposal Facilities				
299-E32-1	.13	.21	<.08	.13
299-E33-3	3.9	5.0	3.0	31.
299-E33-6	.92	1.9	.64	3.9
299-E33-8	.10	.14	.11	.71
299-E33-12	17.	17.	16.	33.
299-E33-13	2.1	3.0	1.9	13.
299-E33-15	8.9	9.1	9.1	150.
299-E34-1	.08	.08	.08	<.08
Wells Monitoring 216-BC Disposal Facilities				
299-E13-13	.17	.29	.17	.14
299-E13-16	.17	.30	.30	.13
299-E13-20	.17	.17	.17	.14

APPENDIX

TABLE I (continued)

Unconfined Ground Water Aquifer

Well Disignation	Avg. Conc. pcB/cc	Max. Conc. pcB/cc	Conc. In Latest Sample pcB/cc	Avg. Conc. 1964 pcB/cc
200-West Area				
Wells Monitoring 216-S Disposal Facilities				
299-W22-1	84.	160.	160.	90.
299-W22-2	1.2	1.2	1.2	1.4
299-W22-12	580.	740.	640.	490.
299-W22-13	490.	520.	470.	930.
299-W22-14	1,300.	4,000.	4,000.	910.
299-W22-19	4.6	8.5	6.0	5.3
299-W22-20	1.3	1.4	1.2	4.0
299-W23-4	1.1	1.6	.76	.69
Wells Monitoring 216-U Disposal Facilities				
299-W19-1	.08	.08	.08	<.08
299-W21-1	.09	.17	.17	<.08
299-W22-22	.09	.13	.13	<.08
Wells Monitoring 216-T Disposal Facilities				
299-W11-10	.09	.08	.10	<.08
299-W14-1	.50	.70	.33	.33
Wells Monitoring 216-Z Disposal Facilities				
299-W15-6	<.08	.08	<.08	.11
299-W18-1	.25	.29	.29	.20
299-W18-6	<.08	.08	<.08	.32
299-W18-7	.11	.12	.12	<.08

Seven additional wells were sampled in the 200 Areas. All results were lower than the routine detection limit of 0.08 pcB/cc.

APPENDIX

TABLE I (continued)

	Unconfined Ground Water Aquifer			
Well Designation	Avg. Conc. pcB/cc	Max. Conc. pcB/cc	Conc. In Latest Sample pcB/cc	Avg. Conc. 1964 pcB/cc
600 Area Wells				
699-S12-29	.09	.09	.09	<.08
699-S6-E4 C	<.08	.10	.10	<.08
699-S3-E12	<.08	.09	<.08	.08
699-1-18	<.08	.09	<.08	.13
699-8-32	<.08	.12	<.08	<.08
699-10-E12	<.08	.13	<.08	<.08
699-15-15	<.08	.08	.08	<.08
699-15-26	.35	.47	.35	.33
699-17-5	<.08	.08	<.08	.08
699-20-20	.14	.24	.14	.25
699-24-46	.08	.08	.08	<.08
699-26-15	.39	.47	.46	.28
699-28-40	.26	.33	.32	.13
699-28-52	<.08	.10	<.08	<.08
699-29-78	.12	.12	.12	<.08
699-30-31	7.2	7.4	7.2	5.6
699-32-70	.25	.25	.25	<.08
699-32-72	.09	.09	.09	<.08
699-34-39A	15.	30.	24.	28.
699-35-66	<.08	.09	<.08	<.08
699-35-78	<.08	.08	.08	<.08
699-37-42	<.08	.09	<.08	<.08
699-37-82A	<.08	.22	.22	<.08
699-37-82B	<.08	.11	<.08	<.08
699-38-70	<.08	.11	<.08	<.08
699-41-23	.19	.38	.21	.20
699-42-12	.09	.38	<.08	<.08
699-42-42	.46	.46	.46	<.08
699-45-20	<.08	.12	<.08	<.08
699-45-69	<.08	.09	.09	<.08
699-47-35	.20	.29	.18	.16
699-47-46	<.08	.09	<.08	<.08
699-49-55	<.08	.10	.10	<.08
699-50-53	6.5	7.2	5.5	25.
699-50-85	<.08	.14	<.08	<.08
699-51-75	<.08	.09	<.08	<.08
699-53-55	<.08	.09	<.08	<.08
699-55-70	.10	.10	.10	<.08
699-55-76	.43	.43	.43	.21
699-56-22	<.08	.09	.09	<.08
699-60-60	.13	.13	.13	<.08
699-63-25	<.08	.08	<.08	<.08
699-63-90	.10	.10	.10	<.08
699-65-72	.08	.15	<.08	<.08

APPENDIX

TABLE I (continued)

Unconfined Ground Water Aquifer

Well Designation	Avg. Conc. pcB/cc	Max. Conc. pcB/cc	Conc. In Latest Sample pcB/cc	Avg. Conc. 1964 pcB/cc
699-66-38	.09	.09	.09	<.08
699-71-52	.08	.12	<.08	<.08
699-74-48	<.08	.09	<.08	<.08
699-74-60	.12	.12	.12	<.08
699-96-49	.52	.60	.60	.60
3099-49-16	.08	.18	<.08	<.08

APPENDIX

TABLE II

RADIOLOGICAL MONITORING DATA FROM GROUND WATER SAMPLES, JANUARY-JUNE, 1965
GROSS BETA ACTIVITY

Piezometer Tube Designation	Depth Below Water Table	Avg. Conc. pcB/cc	Max. Conc. pcB/cc	Conc. In Latest Sample pcB/cc	Avg. Conc. 1964 pcB/cc
200-West Area					
299-W22-14P	98	8.0	9.6	6.4	35.
600 Area					
699-S6-E14P	178	<.08	.16	<.08	<.08
699-S6-E14Q	103	<.08	.11	<.08	<.08
699-10-E12P	283	.12	.42	<.08	.17
699-10-E12Q	223	<.08	.13	<.08	.08
699-10-E12R	163	.08	.16	<.08	<.08
699-10-E12S	103	<.08	.11	.10	<.08
699-S6-E4P		<.08	.21	<.08	<.08
699-15-15P	465	<.08	.13	<.08	<.08
699-15-15R	305	<.08	.11	.10	.12
699-15-15S	225	.14	.18	.12	.11
699-15-15T	145	.08	.11	.09	.08
699-20-E12P	263	<.08	.19	<.08	.11
699-20-E12Q	137	<.08	.11	<.08	<.08
699-20-E12R	105	.10	.14	<.08	.09
699-20-E12S	55	.10	.17	<.08	.28
699-28-40R	193	<.08	.10	.10	<.08
699-30-31P	503	.14	.36	.24	.22
699-30-31R	333	.43	.49	.42	.27
699-30-31S	243	.15	.21	.21	.17
699-20-39T		.13	.17	.17	<.08
699-53-55R		.18	5.3	5.3	<.08

APPENDIX

TABLE III

TRITIUM CONCENTRATIONS IN WELL WATER SAMPLES, JANUARY-JUNE, 1965

Well or Piezometer Designation	Avg. Conc. pc/cc	Max. Conc. pc/cc	Conc. In Latest Sample pc/cc	Avg. Conc. 1964 pc/cc
200-East Area				
299-E24-2	25,000	48,000	13,000	41,000
299-E25-11	570	750	750	980
299-E26-5	2,800	3,100	3,100	105
200-West Area				
299-W6-1	<1	<1	<1	<1.4
299-W10-1	2.5	5.5	<1	<1.8
299-W11-10	<1	<1	<1	1.9
299-W12-1	400	780	3	<1.4
299-W21-1	360	390	370	400
299-W22-14	140,000	160,000	150,000	97,000
299-W22-14P	18,000	19,000	17,000	10,000
299-W22-19	17,000	25,000	16,000	25,000
299-W23-4	57,000	120,000	26,000	98,000
600 Area				
699-S11-E12	<1	<1	<1	<0.6
699-S6-E15	2.5	3.0	2.0	<1.4
699-S3-E12	<1	<1	<1	<0.5
699-1-18	1.9	1.9	1.9	1.7
699-2-3	<1	<1	<1	<0.8
699-8-17	<1	<1	<1	<0.8
699-10-E12	2	2	2	1.6
699-10-E12S	1.5	2.0	2.0	<1.4
699-15-15	1.5	2.0	1.0	<1.4
699-15-15T	2	2	2	1.1
699-15-26	390	390	390	455
699-17-5	<1	<1	<1	<0.5
699-20-E12	1.5	2	<1	1.2
699-20-E12S	1.5	2	<1	2.9
699-20-20	500	650	360	520
699-25-55	<1	<1	<1	<0.5
699-26-15	1,100	1,100	1,000	900
699-27-8	43	45	45	42
699-28-40	81	89	78	23
699-28-52	6	7.6	7.6	<1.4

APPENDIX

TABLE III (continued)

Well or Piezometer Designation	Avg. Conc. pc/cc	Max. Conc. pc/cc	Latest Sample pc/cc	Avg. Conc. 1964 pc/cc
600-Area				
699-30-31	2,600	2,700	2,300	2,900
699-30-31P	130	130	130	200
699-30-31R	2,100	2,300	2,300	110
699-30-31S	67	76	67	135
699-31-53	2	2	2	1.1
699-31-65	2	2	2	<0.8
699-32-62	2	2	2	1
699-32-70	55	63	47	45
699-32-72	8	9	7	9.6
699-34-39A	2,200	2,400	2,000	2,700
699-35-9	<1	<1	<1	<0.8
699-38-70	400	420	420	330
699-40-1	<1	<1	<1	1.8
699-41-23	290	340	260	4,000
699-40-33	<1	2	<1	1.1
699-42-12	<1	<1	<1	1.2
699-42-42	2,300	2,300	2,300	1,200
699-45-20	<1	2	<1	<0.5
699-45-42	220	230	230	270
699-45-69	<1	2	<1	<0.5
699-47-35	<1	2	<1	1.9
699-48-71	<1	2	<1	<0.5
699-50-28	<1	<1	<1	1.4
699-50-30	<1	<1	<1	<0.5
699-50-42	8	14	3	1.1
699-50-53	21	21	21	19
699-53-55	<1	<1	<1	1.2
699-53-55R	<1	<1	<1	<1.5
699-54-42	<1	<1	<1	
699-54-57	<1	<1	<1	<0.5
699-55-50A	3	3	3	
699-55-50P	5	5	5	