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RADIOLOGICAL STATUS
OF THE GROUNDWATER
BENEATH THE HANFORD PROJECT
JULY-DECEMBER 1971

Battelle

Pacific Northwest Laboratories
Richland, Washington 99352

JANUARY 1973

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by

K. L. Kipp, Jr.

Water Resources Systems Section

January 1973

BATTELLE
PACIFIC NORTHWEST LABORATORIES
RICHLAND, WASHINGTON 99352

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INTRODUCTION

This report is prepared semi-annually to provide an evaluation of the status of groundwater contamination resulting from disposal of Hanford plant effluents. The data presented in this report were collected during the last six months of 1971; the previous report in this series was BNWL-1649.⁽¹⁾

Of the wells that have been drilled to the groundwater on the Hanford project, about 200 are used for the routine surveillance of radionuclide movement through the sediments below the regional water table. Approximately one-third of the surveillance wells are located at disposal sites situated in or near the 200 separations areas. Many of these wells are used to determine when a disposal facility is to be retired. Almost all other surveillance wells are sampled to determine the status of contaminants within the groundwater system. With the exception of wells drilled since 1968, a description of wells referred to in this report may be found by referring to the Hanford Wells document.⁽²⁾ All sampled wells outside and some of the wells inside the 100, 200 and 300 Areas are shown in Figures 1, 2, and 3.

The radionuclides Ruthenium-Rhodium and Tritium, as well as the nitrate ion (NO_3), are readily transported by the groundwater and can be detected in groundwater at low concentrations relative to their respective drinking water standards. Therefore, these substances are used to trace the movement of contaminated groundwater away from the major disposal sites.

The groundwater contamination pattern beneath Hanford at the present time can be divided into three source zones, based on the kinds and quantities of wastes disposed to ground at each location:

- 200 Areas (chemical processing areas) and associated 600 Area wells
- 100 Areas (production reactor areas) and associated 600 Area wells
- 300 Area (fuel fabrication and laboratory area) and associated 600 Area wells

Groundwater concentration data for these three source zones are presented in this report. All groundwater samples reported here were taken by the Radiation Monitoring Section and were analyzed by the Technical Analysis Section of Battelle-Northwest as part of the Hanford environmental surveillance program conducted by the Environmental Evaluations Section.

SUMMARY

An evaluation of $^{106}\text{Ru-Rh}$ and ^3H concentrations measured near the surface of the unconfined groundwater during the last half of 1971 showed that zones of detectable contamination extended in an easterly to south-easterly direction from 200-E Area (Figures 1 and 2), as has been observed in the past.⁽¹⁾ Measurable ^3H and NO_3^- concentrations were found along the Columbia River in the vicinity of the 100 Areas (Figures 2 and 3). A low groundwater mound showing uranium and nitrate ion continued to be observed in the 300 Area (Figure 3). A few locations for which average groundwater concentrations exceeded the Concentration Guide (CG) of 10 pCi/ml for $^{106}\text{Ru-Rh}$ were within either the 200-E or 200-W Areas with the exception of Well 299-E26-7 which monitors the 216-A-24 crib. During this report period concentrations of ^{106}Ru were measured independently from the total beta measurements. Significant concentrations (over 10% of CG) were found only in the 200 Areas. Total beta activity concentrations in the groundwater beneath the 100 Areas were detectable only at 100-N Area from the normal effluent discharge to the 1301 crib.

A concentration of ^3H that exceeded the Concentration Guide of 3000 pCi/ml (outside the area boundaries) was found in Well 699-35-70 (outside the south-east corner of 200-W Area). A small region in the north part of 200-E Area which formerly had an average tritium concentration greater than the Concentration Guide is now within the 10 to 100% zone of the Concentration Guide.

FIGURE 1

FIGURE 2

FIGURE 3

Nitrate ion concentrations greater than 10% of the Public Health Service (PHS) recommended drinking water standard of 45 ppm⁽⁴⁾ were observed in most groundwater samples from wells within and in the immediate vicinity of the 100-F, 200 and 300 Areas. However, groundwater from these zones is not consumed by humans or animals. The 10% contour of PHS recommended drinking water standard nitrate concentration has been extended west of the 200-West Area to include wells 699-43-89 and 699-37-82A. There are no major changes in other isopleth contours since the previous report period (January-June 1971).

Although water samples from several wells with piezometer tubes extending to deep aquifers were obtained and analyzed for tritium and nitrate during this report period, all such samples had tritium concentrations less than the analytical limit of 1 pCi/ml and nitrate concentrations less than 1 ppm.

EVALUATION OF GROUNDWATER SURVEILLANCE DATA

Radionuclide concentrations in the groundwater beneath Hanford are evaluated in terms of their respective Concentration Guides (CG's), while the NO_3^- concentrations are compared to the PHS recommended drinking water standard.⁽⁴⁾ It is recognized that these guides are intended only for drinking water, and at present no groundwater from zones having concentrations greater than 10% of the employed standards (Figures 1-3) is used for human or animal consumption. However, they do provide a rapid and meaningful method of evaluating the potential significance of most waterborne materials. The Concentration Guides used in this report are those which apply to individuals of the general public.⁽³⁾

Data from those 200 Area and associated 600 Area wells for which average total beta, ^3H or NO_3^- concentrations were above the respective analytical limits during the report period appear in Tables 1 and 2. All 100 Area and associated 600 Area wells routinely sampled are listed in Table 5, along with the concentration data for those wells showing detectable activity. The analytical data for wells within or near the 300 Area appear in Table 6. In addition, the average concentration data for the first half of 1971 are shown

in Tables 1, 2, 5, and 6 for rapid comparison of the respective trends. A number of other wells, particularly those immediately down-gradient from wells with observed contamination, were sampled and analyzed on a routine schedule and are included in the Tables.

200 Area and Associated 600 Area Wells

Groundwater samples collected from wells within and near the zone in which 200 Area effluents have been detected are analyzed for total beta, ^3H , and NO_3^- . The total beta activity is calculated as $^{106}\text{Ru-Rh}$, since radiochemical analyses have shown that this nuclide accounts for a large fraction ($\sim 80\%$) of the radioactivity* in this groundwater zone. Under the direction of ARHCO, groundwater samples from beneath some inactive and all of the active disposal sites within the 200 Areas are generally analyzed for total alpha, ^{60}Co , ^{90}Sr , and ^{137}Cs , in addition to total beta, ^3H and NO_3^- . Starting this period ^{106}Ru was measured independently of the total beta activity for these wells. Tables 3 and 4 show the active and cited inactive disposal sites, along with associated wells that were sampled during this report period.

Cesium-137 concentrations were detected in the groundwater beneath the 200-East Area between the 216-B-46 and 216-B-50 crib sites (only the 216-B-50 site was active during this period), and near the B-2 ditch. The detection limit for ^{137}Cs is 0.03 pCi/ml and the Concentration Guide is 20 pCi/ml. Average concentrations were 0.78 and 0.07 pCi/ml at these respective sites. Average Cesium-137 concentrations of less than 0.04 pCi/ml were measured at the wells monitoring crib site 216-S-23 in 200-West Area. The average ^{137}Cs concentration at the 216-S-9 site was less than 0.10 pCi/ml, a decrease from 0.24 pCi/ml observed during the previous report period. The reported results are consistent with values observed during the previous reporting period.

* Not including ^3H , whose low energy beta emission does not contribute to the total beta activity measured. Other beta-gamma emitters which have been identified in the groundwater away from the disposal sites but within the beta zones of Figure 1 include ^{99}Tc , U, ^{60}Co , ^{51}Cr , and ^{155}Eu .

^{90}Sr concentrations averaged 0.067, 20 and 0.17 pCi/ml in the groundwater near the 216-A-36B, 216-S-1, and 216-S-2 crib sites, respectively, during the last half of 1971. This represents a decrease in average concentration of 20% at 216-S-1 and 55% at 216-S-2 (both inactive sites) from the previous reporting period. The 216-A-10 crib site showed about a 15% decrease. Analysis of the groundwater at the 216-A-5 crib site (inactive) showed an average concentration of ^{90}Sr of 0.033 pCi/ml. The detection limit for ^{90}Sr is 0.03 pCi/ml and the CG is 0.3 pCi/ml.

Total alpha concentrations averaged 0.07, 0.03, 1.97, and 0.07 pCi/ml in the groundwater near the 216-A-27, 216-B10-B, 216-S-13, and 216-S-21 crib sites, respectively, during the last half of 1971. The detection limit for alpha is 0.02 pCi/ml calibrated for ^{239}Pu . Significant increases of about 90% were observed at both 216-A-27 and 216-S-13 crib sites. The alpha activity at 216-S-13 crib was due entirely to an average uranium concentration of 2.6 pCi/ml (with a CG of 20 pCi/ml), as has been the case in the past.⁽¹⁾

Table 2 contains the results of initial routine ^{106}Ru concentration measurements in the 200 Areas. The average concentrations were above the Concentration Guide (10 pCi/ml) at the 216-S-9 and 216-S-23 disposal sites. The observed concentrations were 120 and 36 pCi/ml, respectively. The 216-S-23 crib was active during this period.

The highest average total beta concentrations observed beneath active disposal sites in the 200-East Area were at the 216-A-36B crib (7.9 pCi/ml). The 216-B-50 and 216-B-57 crib sites had the second and third highest average total beta concentrations during this period with 5.8 pCi/ml and 5.4 pCi/ml, respectively. The latter site had the highest average total beta concentration during the January-June 1971 period. The 216-S-23 crib still had the highest average total beta concentration (72 pCi/ml) for an active disposal site in the 200-West Area in the second half of 1971.

The highest average total beta concentrations measured near inactive disposal sites in the 200-East Area were at the east side of the 241-BX Tank Farm (21 pCi/ml). In the 200-West Area the 216-S-9 crib area monitoring

wells had the highest average total beta concentration (230 pCi/ml). This represents no significant change at the 241-BX Tank Farm but a decrease of 24% at the 216-S-9 site.

Total Beta Concentrations (Unconfined Aquifer)

Total beta concentrations are shown in Figure 1 for zones of 2 to 10%, 10 to 100%, and > 100% of the CG for $^{106}\text{Ru-Rh}$ (10 pCi/ml).⁽³⁾ The outer boundary of each zone is the down-gradient edge and represents the 2%, 10%, and 100% CG isopleth, respectively. The lowest level shown (2% CG) corresponds to a total beta concentration of 0.2 pCi/ml.

It should be kept in mind that these isopleth contours represent averages of the data that were collected over a six-month period. Thus, apparent short-term fluctuations, both increases and decreases, are effectively filtered out in this pictorial representation. Furthermore, much of the topography of the concentration isopleth surface does not appear when only three or four CG isopleths are used to illustrate it.

A comparison of the CG isopleths for the six-month periods ending June 1971 and December 1971 indicates only a few minor concentration contour adjustments. In the 200-West Area the 10-100% CG zone has been extended to include disposal sites 216-T-34 and 216-T-35 which have been in this concentration zone for several years. This omission was a cartographic error on the last total beta map. The 10-100% of CG zone has been extended into the northeast corner of the 200-East Area based on results from well 299-E-26-1 which was added to the sample schedule this period. The average total beta concentration at well 699-50-53 has dropped from 10-100% of CG zone to 2-10% of CG zone.

Tritium Concentrations (Unconfined Aquifer)

Tritium concentrations are shown in Figure 2 for zones of 0.03 to 1%, 1 to 10%, 10 to 100%, and > 100% of the CG (3000 pCi/ml).⁽³⁾ The outer boundary of each zone is the down-gradient edge and represents the 0.03%, 1%, 10%, and 100% CG isopleth, respectively. Comments made previously about the average nature of the isopleth contours apply here also.

A comparison of the CG isopleths for the six-month period ending June, 1971, and December, 1971, indicates that several minor changes have occurred. In the 200-West Area the 1-10% of CG zone was extended to include the 216-T-34 and 216-T-35 cribs. As in the total beta map, this also was an earlier cartographic error. The following wells were included within the 0.03-1% CG zone last period due to one positive result from each: 699-49-79, 699-50-42, and 699-46-21. These wells are sampled quarterly and showed no detectable tritium this period. Well 699-40-1 continued to show intermittent tritium activity; however, no contour adjustment was made pending further investigation into the reliability of results from that well structure. The zone of tritium concentration previously shown as greater than the Concentration Guide in the northern part of the 200-East Area now appears to be in the 10-100% CG zone. There was no significant movement of the 200-East Area plume in the southeasterly direction.

The concentration zone boundaries shown in Figures 1 and 2 should not be interpreted as indicating that no radioactivity is present in the groundwater beyond these outer boundaries. It is probable that some radionuclides do in fact reach the river, but because of dilution and decay, the concentrations in the groundwater outside the lowest contour are too low to be measured by current techniques. Tritium is measurable in the Columbia River from non-plant sources, but any contribution from the 200-Area plume is too low to be distinguished.

Nitrate Ion (NO_3^-) Concentrations (Unconfined Aquifer)

Nitrate ion (NO_3^-) concentrations are shown in Figure 3 for zones of 10 to 100% and > 100% of the U.S. Public Health Service drinking water standard, 45 ppm.⁽⁴⁾ The outer boundary of each zone is the down-gradient edge and represents 10% and 100% of the drinking water standard, respectively.

A comparison of contamination contours for the six-month periods ending June 1971 and December 1971 indicates that a few changes in the 10% drinking water standard isopleth occurred. The most significant change in the nitrate contamination pattern is the westward extension from the 200-West Area to

include wells 699-43-89 and 699-37-82A. The former well was reinstated into the sample schedule this period after a lapse of two years. It was previously sampled only for total beta analysis. The latter well has shown a rapid, steady increase to 15 ppm nitrate concentration. The average nitrate concentration in well 699-50-53 has declined to the 10-100% of PHS drinking water standard zone. The average nitrate concentration near 216-A-8 disposal site increased to 56 ppm (Well 299-E25-6) which is above the PHS recommended drinking water standard. Investigation of the sample concentration histories of Wells 699-31-53B and 699-34-51 showed that the 10% contour in their area should be drawn as indicated. The average concentration in 699-34-51 was 1.9 ppm which is somewhat below the 10% of drinking water standard isopleth.

The zone of greater than 100% of the PHS recommended drinking water standard for nitrate in the 200-East Area plume now extends south to well 699-20-20. Well 699-46-21 is now at the 10% level of nitrate contamination as is well 699-1-18, although results from the latter are somewhat erratic.

TABLE 1: Average Total Beta, Tritium, and Nitrate Ion (NO_3^-) Concentrations in 600 Area Wells Associated with the 200 Areas

Well No.	Total Beta (pCi/ml)		Tritium (pCi/ml)		NO_3^- (ppm)	
	Jan-June 1971	July-Dec 1971	Jan-June 1971	July-Dec 1971	Jan-June 1971	July-Dec 1971
Analytical Limit	0.16		1.0		0.5	
Concentration Guide	10		3000		45	
699-S3-E12			*	*	1.7	2.3
S3-25			*	*	0.75	*
S6-E4C-0			*	*	0.8	*
S6-E14-0				*	1.0	0.6
S8-19			3.0	*	*	<1.0
S11-E12-0			*	*	2.8	10
S12-3			3.8	*	*	0.7
S18-E2-0						*
S27-E14						6.4
1-18			147	160	<0.6	7.6
2-3		*	13	15	3.3	9.3
2-33-0					<0.7	*
8-17		*	63	76	19	22
8-25		240	350	300	26	31
8-32			*	*	<1.0	<0.6
9-E2			*	*	0.75	*
10-E12-0					12	15
14-E6-T					2.2	*
14-38-0			1.1	*	4.0	3.8
15-15-0	*	*	1.0	4.7	7.7	7.8
15-26	0.27	0.23	520	510	29	29
17-5			*	*	<2.2	<1.1
19-43					1.5	1.7
20-E5-T					*	*
20-E12-0			*	*	*	*
20-20	<0.22	0.22	690	670	44	45
20-39-0			1.2	*	7.8	7.4
24-1-T			*	*	*	<0.6
24-33	<0.20	*	445	420	3.0	2.2
24-46			*	*	3.9	3.8
25-55					1.7	*
25-70-0			*		2.1	2.5
26-15	0.63	0.61		1400	48	55
26-89					0.7	3.2
27-8	*	*	925	965	12	16
28-40	*	*	60	49	10	8.6

TABLE 1 (contd)

Well No.	Total Beta (pCi/ml)		Tritium (pCi/ml)		NO ₃ (ppm)	
	Jan-June 1971	July-Dec 1971	Jan-June 1971	July-Dec 1971	Jan-June 1971	July-Dec 1971
Analytical Limit	0.16		1.0		0.5	
Concentration Guide	10		3000		45	
699-29-78			1.3	*	1.8	1.2
31-31-0	0.53	0.55	1900	1900	27	33
31-53B-0	*	*	*	*	5.5	3.4
31-65-0			*	4.5	1.0	*
32-22	0.46	0.36	1700	1700	56	39
32-43	0.49	0.52	800		30	36
32-62-0	*	*	*	*	0.8	2.7
32-70	*	*	33	33.5	25	18
32-72-0	*	*	72	70	*	*
32-77			1.2	4	13	15
33-56	*	*	2.2	*	<0.85	*
34-39A	0.28	*	2000	2000	15	4.2
34-41	1.1	0.94	2600	2200	66	31
34-42	1.3	1.0	2633	2200	69	140
34-51			*	*	3.1	1.9
34-88-0			*	*	2.6	1.9
35-9	*	*	17.5	24	3.8	5.6
35-66	*	*	<1.1	*	<0.7	*
35-70	*	0.25	6933	7200	1.6	2.6
35-78	*	*	7.7	1.5	<1.0	1.0
36-46-R	0.2	*	2300	2200	1.4	1.0
36-61B-0	*	*	*	*	*	*
36-93-0			*	*	<0.8	*
37-43-0	*	*	103	75	<3.2	*
37-82A-0			*	*	3.9	10
38-65-0	*	*	6.5	6.0	32	17
38-70-0	1.2	0.89	157	130	123	150
39-39	0.23	<0.65	*	*	*	*
39-79-0	*	*	1.9	1.8	<1.5	<1.2
40-1			1.3	2.4	*	<4.8
40-33	*	*	1.2	1.0	*	*
40-62			*	*	13	12
41-23	0.27	0.28	780	795	48	50
42-12	*	*	155	180	18	18
43-42		<0.29				
43-89				*		30

TABLE 1 (contd)

Well No.	Total Beta (pCi/ml)		Tritium (pCi/ml)		NU ₃ (ppm)	
	Jan-June 1971	July-Dec 1971	Jan-June 1971	July-Dec 1971	Jan-June 1971	July-Dec 1971
Analytical Limit	0.16		1.0		0.5	
Concentration Guide	10		3000		45	
699-44-64-0			6.9	*	12	12
45-42			940		2.2	
45-69			*	<1.1	30	36
46-21			<3.3	*	3.2	4.7
47-35			*	*	1.9	2.2
47-46			*	*	20	12
47-60			<2.6	*	4.5	6.4
48-71			*	*	1.3	1.9
49-55	*	*	*	*	<0.7	*
49-57			1.9	7.2	1.5	1.6
49-79			4.5	*	35	33
50-28	*	*	*	*	4.5	4.2
50-42-0			*	2.6	*	*
50-53	0.33	1.51	1.6	4.7	171	36
50-85					11	11
51-63			*	*	1.5	1.2
53-47			2.9	3.3	*	*
53-55-0			1.8	1.6	*	*
54-37					4.7	
54-42			*	*	2.4	3.6
54-57			*	*	<0.7	*
55-21					*	1.6
55-50A			2.0	2.1	*	*
55-70-0					<0.8	<0.6
55-76-0					<0.8	*
55-89-0					<0.8	*
55-95					<2.2	<0.8
57-83-0					<0.8	*
59-80B					4.3	4.8
HAN-6					2.4	1.6
HAN-9					2.8	2.4
HAN-19			*	*	*	2.1

Total Beta is calculated as ¹⁰⁶Ru-Rh.

* Indicates that the concentration was less than the analytical limit.
No entry indicates no analyses were performed during the six-month period.

TABLE 2. Average Total Beta, ^{60}Co , Nitrate, and ^{106}Ru Concentrations
in the Unconfined Groundwater Within the 200 Areas

Part A: Wells Near Active Crib Sites

Well No. (299-)	Total Beta (pCi/ml)		^{60}Co (pCi/ml)		NO_3^- (ppm)		^{106}Ru (pCi/ml)
	Jan-June 1971	July-Dec 1971	Jan-June 1971	July-Dec 1971	Jan-June 1971	July-Dec 1971	July-Dec 1971
Analytical Limit	0.16		0.03		0.5		.10
Concentration Guide	10		20		45		10
E16-2	1.6	1.6			3.3	1.8	
E17-1	1.1	0.95	0.22	0.19	90	93	0.18
E17-4	3.1	2.0	0.33	0.13			0.70
E17-5	9.5	2.4	0.58	0.18	320	255	1.2
E17-6	<0.17	<0.23	*				
E17-7	6.2	1.9	0.46	0.13	290	268	0.88
E17-9	9.8	7.9	*	*			4.03
E17-10	2.6	2.1					
E24-2	1.6	0.99	0.14	0.05	240	200	0.37
E24-10	0.37	<0.21			*	*	
E25-5	0.94	0.36					
E25-6	0.56	0.27	*	*	30	56	0.16
E25-7	*				43		
E25-9	*	*					
E25-11	1.2	1.4		*			0.71
E25-12	1.0	0.74					
E28-9	0.26	0.29	*	*	305	219	0.14
E28-12	<0.27	*	*	*	110		*
E28-13	*	<0.17	*	*		77	*
E28-16	0.36		*		380	300	0.13
E28-17	*	<0.19					
E33-7	8.1	5.8	10.8	5.8			0.37
E33-23	1.3	2.0	0.30	0.36	<5.2	9.7	0.19
E33-24	11.5	5.4	6.2	3.5			1.09
W15-4	1.1	0.40		*	120	238	0.26
W15-10	*	*					
W15-11	*	*					
W18-1	<0.20	*					
W18-2	*	*					
W18-4	*	*					
W18-5	*	*			*	*	
W18-10	<0.35	*					
W18-11	0.85						

TABLE 2 (contd)

Part A (Continued): Wells Near Active Crib Sites

Well No. (299-)	Total Beta (pCi/ml)		^{60}Co (pCi/ml)		NO_3^- (ppm)		^{106}Ru (pCi/ml)
	Jan-June 1971	July-Dec 1971	Jan-June 1971	July-Dec 1971	Jan-June 1971	July-Dec 1971	July-Dec 1971
W19-5	120	72	*	*	80	84	36
W19-7	*	0.97	*				
W22-22	0.9	1.5			<0.8	*	
W22-38	<0.31	*	*				
W26-3	0.39	0.20	*	*	3.9	3.6	0.11

Part B: Wells Near Inactive Crib Sites with Average Total Beta Concentrations Greater than 10% CG (1 pCi/ml)

Well No. (299-)	Jan-June 1971	July-Dec 1971	Jan-June 1971	July-Dec 1971	Jan-June 1971	July-Dec 1971	July-Dec 1971
Analytical Limit		0.16		0.03		0.5	0.1
Concentration Guide		10		20		45	10
E24-9	1.1	1.1			210	230	
E26-1		3.5		*			1.7
E26-4		3.4					1.6
E33-9	7.3	9.0					
E33-18	1.1	1.1					
E33-25	4.3	2.5			584	273	
E33-26	3.4	1.1					
E33-27	21.8	21.3			*	*	
W11-15	6.5	4.0	0.031	*			2.0
W11-17	2.1	1.0	0.039	*	410	365	0.43
W11-21	8.6		0.093		565		
W14-2	16	11.3	0.048	0.06	640	637	6.03
W15-7	4.4	3.2	3.3	3.03	44	57	*
W22-1	54	40					
W22-13	3.7	4.0		*			1.83
W22-21	26	28			*		
W22-26	298	230	0.36	0.37	197	200	120

Total Beta is calculated as $^{106}\text{Ru-Rh}$.

* Indicates that the concentration was less than the analytical limit.
No entry indicates no analyses were performed during the six-month period.

TABLE 3. Active Disposal Sites--Cribs, Ditches, Ponds, Swamps200 East Area
Site Designation

<u>Purex</u>	<u>Associated Sample Wells</u>
216-A-8	299-E25-4, -E25-5, -E25-6, -E25-7, -E25-9
216-A-10	299-E17-1, -E24-2,
216-A-25	699-53-47, -55-50
216-A-29	-----
216-A-30	299-E25-11, -E25-12, -E16-2
216-A-36B	299-E17-4, -E17-5, -E17-6, -E17-7, -E17-9, -E17-10

B-Plant

216-B-2	299-E34-1
216-B-3	699-42-42, -43-42
216-B-10-B	299-E28-17
216-B-12	299-E28-9, -E28-16
216-B-50	299-E33-7, -E33-23
216-B-55	299-E28-12, -E28-13
216-B-57	299-E33-24
216-B-63	299-E34-1

Hot Semi-Works

216-C-7	-----
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200 West Area
Site Designation

	<u>Associated Sample Wells</u>
216-S-6	299-W26-3
216-S-11	699-32-77
216-S-16	-----
216-S-19	699-32-72
216-S-23	299-W19-5, -W-19-6, -W19-7, -W22-38
216-S-24	-----

TABLE 3 (contd)

<u>200 West Area Site Designation</u>	<u>Associated Sample Wells</u>
<u>T-Plant</u>	
216-T-4	699-49-79
216-T-19	299-W15-4
<u>U-Plant</u>	
216-U-10	699-35-78
216-U-12	299-W22-22
216-U-14	-----
<u>Z-Plant</u>	
216-Z-11	-----
216-Z-12	299-W18-1, -W18-2, -W18-4, -W-18-5
216-Z-16	299-W15-10, -W15-11
216-Z-18	299-W18-10, -W18-11

TABLE 4. Cited Inactive Disposal Sites

<u>200 East Area Site Designation</u>	<u>Associated Sample Wells</u>
<u>Purex</u>	
216-A-5	299-E24-10
216-A-24	299-E26-2, -E26-3, E26-4, E26-5,
216-A-27	299-E17-2, -E17-3
<u>B Plant</u>	
216-B-36	299-E33-21
216-B-46	299-E33-4, -E33-23
216-B-49	299-E33-7
241-BX-1, 2	299-E33-27
<u>200 West Area Site Designation</u>	<u>Associated Sample Wells</u>
216-S-1	299-W22-1
216-S-2	299-W22-2
216-S-9	299-W22-25, -W22-26, -W22-27
216-S-13	299-W22-21
216-S-20	299-W22-19, -W22-20
216-S-21	299-W23-4

Analyses of Samples Taken from Deep Aquifers

Water samples from specific depths below the Hanford Reservation's regional water table are obtained from either vertically separated tubes (piezometers) contained within a single well or from piezometer tubes drilled as separate wells. Those few wells which have shown detectable beta activity have not done so consistently with time. A few wells have exhibited detectable ^3H concentrations intermittently; however, there is no certainty that the vertical separation of piezometer tubes is infallible and in fact, Eliason⁽⁵⁾ has shown that interaquifer transfer within a well can occur.

At present, it is believed that none of the deep aquifers being sampled contain any beta radioactivity at the points where they are sampled. Tritium concentrations in these same samples were all below the detection limit during this report period. Detectable nitrate ion concentrations of 0.65 and 1.0 ppm were observed in wells 699-36-61B-P and 699-38-65-P, respectively. These values are essentially unchanged from previous report periods.

100 Area and Associated 600 Area Wells

The presence of radioactivity in the groundwater beneath the 100 Areas is due primarily to disposal of wastes to trenches and cribs, although leaks in reactor effluent systems have contributed radioactivity to the groundwater in the past. Some well water samples, collected from within the 100 Areas, were analyzed for ^{51}Cr in addition to total beta, tritium and nitrate ion.

Total Beta Concentrations (Unconfined Aquifer)

The estimated extent of detectable total beta radioactivity (excluding tritium) in the groundwater beneath the 100 Areas and vicinity is shown in Figure 1. A comparison of data for the six-month periods ending June 1971 and December 1971 indicates that the total beta activity is below the detection level (0.16 pCi/ml) in all areas except 100-N, as was noted in the previous report period. The highest average total beta concentration was measured in well 199-N-10-0 (1.6 pCi/ml). This is a decrease of 35% from the previous report period.

TABLE 5. Average Total Beta Tritium and Nitrate Concentrations in 100 Area and Associated 600 Area Wells

Well No.	Total Beta (pCi/ml)		Tritium (pCi/ml)		NO ₃ ⁻ (ppm)	
	Jan-June 1971	July-Dec 1971	Jan-June 1971	July-Dec 1971	Jan-June 1971	July-Dec 1971
Analytical Limit	0.16		1.0		0.5	
Concentration Guide	10		3000		45	
199-B3-1	*					
B3-2	<0.19	<0.26				
B4-4	*	*	7.3	5.0	0.6	1.0
D2-5			3.9	9.3	4.8	57
D5-12	<0.18	0.30	7.9	8.4	23	42
F5-1			1.1	*	*	<1.2
F7-1			1.8			
F8-1			18.5	16.5	64	54
H3-1			19.5	18.0	12	8.8
K-11			120	105	*	*
K-20	*	*	11.4	7.8	1.2	<0.6
N-3-0	0.51	1.0	50	500	1.5	
N-4-0	<0.29	*	314	53	1.8	*
N-10-0	2.2	1.6	69	106	6.2	
699-59-33					<0.6	*
60-60			*	*	1.0	<0.65
61-66			*	*	2.0	3.4
62-32			*		6.6	3.4
62-43F					<1.2	<0.7
63-25					*	<0.6
63-90					4.5	3.4
65-50				*	0.8	0.7
65-59			1.1	1.6	1.6	0.7
65-72			1.9	1.6	*	*
65-83			2.1	2.9	1.4	0.7
66-23-0					*	*
66-38					1.3	<0.6
67-51-0			*	*	2.6	2.0
67-86			4.0	4.3	2.2	1.4
67-98			1.2	1.3	2.2	2.4
69-38					*	18
69-45-0			<1.2	*	*	*
70-68			2.7	1.1	4.2	2.2
71-30			*	*	23	1.6
71-52			6.4	5.5	6.6	5.7
71-77			3.0	2.1	3.2	2.5
71-84			6.5		2.6	

TABLE 5 (contd)

Well No.	Total Beta (pCi/ml)		Tritium (pCi/ml)		NO ₃ ⁻ (ppm)	
	Jan-June 1971	July-Dec 1971	Jan-June 1971	July-Dec 1971	Jan-June 1971	July-Dec 1971
Analytical Limit	0.16		1.0		0.5	
Concentration Guide	10		3000		45	
699-72-73			6.5	4.4	5.4	3.4
72-88			19	19.5	*	*
72-92-0			32	23	3.4	3.2
72-98			17	14	*	*
74-44			*	*	*	*
74-48			1.4	1.3	4.6	2.4
77-36			*	*	145	120
77-54			*	*	7.2	4.8
78-62			*	*	11	*
80-43S			*	*	0.6	<0.9
81-58-0			*	<1.1	1.4	1.4
83-47-0			*	*	*	*
84-35			1.2	2.4	16	9.9
86-60	<0.31	0.33	170	180	5.8	6.4
87-42			1.1	*	2.0	0.8
87-55			30	24	6.1	5.1
89-35			*	*		4.4
90-45			61	62	*	*
96-49-0			10	23	3.3	2.7
97-43-0			11	8.5	2.7	7.3

Total Beta is calculated as ¹⁰⁶Ru-Rh.

* Indicates that the concentration was less than the analytical limit.
No entry indicates no analyses were performed during the six-month period.

Tritium Concentrations (Unconfined Aquifer)

The extent of detectable tritium activity in the groundwater beneath the 100 Areas and vicinity is shown in Figure 2. The 1 to 10% CG zone in the 100 Areas is actually in three zones as shown in Figure 2. There is one small zone in the 10 to 100% CG range at Well 199-N-3-0 (500 pCi/ml) which increased by a factor of 10 since the last report period.

The average concentration of tritium in Well 199-N-10-0 increased 53% to 106 pCi/ml. These increases were due to increased tritium discharges to the 1301-N crib during July-December 1971.

Nitrate Ion Concentrations (Unconfined Aquifer)

There were no major changes in the nitrate contamination zone contours in the vicinity of the 100 Areas during this report period. Newly sampled Well 699-89-35 is at the 10% of PHS drinking water standard level, while 699-97-43 is now included in the 10-100% zone. Average nitrate concentrations in three wells (699-72-73, 699-74-48, and 699-62-32) dropped below the 10% level. The only area greater than 100% of drinking water standard is southwest of 100-F Area, probably from the Battelle-Northwest animal research wastes.

The origin of the other zones of high nitrate ion concentration in the vicinity of the 100 Areas is not certain but it is believed to be associated with agricultural sources rather than Hanford Plant operations.

300 Area and Associated 600 Area Wells

The presence of radioactive and nonradioactive contaminants in the groundwater beneath the 300 Area arises primarily from the disposal of low-level fuel processing wastes to two process ponds located northeast and east of the 300 Area. Results of samples collected from 300 Area and associated 600 Area wells show that the radioactivity is primarily due to uranium, although ^{51}Cr , ^{60}Co , and ^{106}Ru -Rh have also been identified on occasion as mentioned in previous reports. The relatively high total beta concentration in Well 399-3-8 is due to a previously reported leakage of waste solutions from a line (since repaired) to the 340 Laboratory waste handling facilities.

TABLE 6. Analytical Data - 300 Area and Associated 600 Area Wells

Well No.	Total Beta (pCi/ml)				NO ₃ (ppm)				Alpha (pCi/ml)				Cr ⁺⁶ (ppb)				F ⁻ (ppm)			
	Jan - June 71	July - Dec 71	Jan - June 71	July - Dec 71	Jan - June 71	July - Dec 71	Jan - June 71	July - Dec 71	Jan - June 71	July - Dec 71	Jan - June 71	July - Dec 71	Jan - June 71	July - Dec 71	Jan - June 71	July - Dec 71	Jan - June 71	July - Dec 71	Jan - June 71	July - Dec 71
Analytical Limit	0.16				0.5				0.02				3				0.2			
Concentration Guide	10				45				5				50				1.5			
699-S27-E14																				
399-1-1	<0.18	0.25	9.4	6.4	33	35	*	*	0.09	0.05	4.0	<3	0.23	0.26						
1-2	*	<0.17	56	22	56	22	0.09	0.09	0.09	0.084	4.9	<15	1.3	1.2						
1-3	*	*	79	64	79	64	0.18	0.18	0.11	0.11	7.1	4.5	1.3	1.2						
1-4	*	*	39	14	39	14	0.04	0.04	0.07	0.07	<2.8	<2.8	2.2	1.2						
2-1			40	40	40	40			0.16				1.0	0.7						
3-1	*	*	45	30	45	30	0.08	0.08	0.096		5.2	2.9	1.3	1.0						
3-8	7.5	2.9	55	32	55	32	0.07	0.07	0.054		3.3	<2.8	1.6	1.3						
4-1	*	*	25	28	25	28	0.11	0.11	0.11		<4.5	2.8	1.1	1.0						
4-7	*	*	44	42	44	42	0.07	0.07	0.15		5.7	3.9	0.83	1.2						
5-1			16	15	16	15	*	*	*		<5.0	2.8	0.25	0.3						
6-1			12	10	12	10	*	*	<0.023		5.5	4.4	0.25	0.3						
8-2			5.5	5.9	5.5	5.9	*	*	*		<3	<3.3	0.3	0.27						
8-3			8.9	12	8.9	12	*	*	*		<3.6	<2.9	0.3	0.4						

Total Beta is calculated as ¹⁰⁶Ru-Rh.
Total Alpha concentrations are calibrated for ²³⁹Pu.

* Indicates that the concentration was less than the analytical limit.
No entry indicates no analyses were performed during the six month period.

Its average total beta concentration decreased 60% since January-June 1971. The average ^{106}Ru concentration measured in Well 399-3-8 was 0.95 pCi/ml.

The concentration of NO_3^- in much of the groundwater beneath the 300 Area (Table 6) is above the Public Health Service drinking water limit⁽⁴⁾ of 45 ppm. There has been a general decrease in nitrate concentration measured in the 300 Area wells averaging about 17% less than the levels observed during the January-June 1971 period.

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