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RADIOLOGICAL STATUS OF THE GROUNDWATER
BENEATH THE HANFORD PROJECT
JANUARY-JUNE 1972
K.L. Kipp, Jr.

Battelle

Pacific Northwest Laboratories
Richland, Washington 99352

MAY 1973

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K. L. Kipp, Jr.
Water Resources Systems Section

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K. L. Kipp, Jr.

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 first six months of 1972; the previous report in this series was BNWL-1680.⁽¹⁾

Of the wells that have been drilled to the groundwater on the Hanford project, about 300 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-106 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 at the Chemical Separations Facilities (200 Areas).

At the 100-N Reactor Area radioactivity in the groundwater from ground disposal of wastes is predominantly tritium, chromium-51, and strontium-90.

FIGURE 1.

FIGURE 2.

FIGURE 3.

At the 300 Laboratory Area measurable radioactivity in the groundwater from fuel fabrication and laboratory waste disposal to ground is predominantly uranium.

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 as part of the Hanford environmental surveillance program conducted by the Environmental Evaluations Section of Battelle-Northwest.

SUMMARY

An evaluation of $^{106}\text{Ru-Rh}$ and ^3H concentrations measured near the surface of the unconfined groundwater during the first half of 1972 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 tritium and nitrate ion 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. Significant concentrations of ^{106}Ru (over 10% of CG) were found only in the 200 Areas. Gross 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) as has been noted previously.⁽¹⁾

A moderate increase in tritium concentration levels and extent in the vicinity of 100 N area occurred during this report period due to processing of tritium bearing target elements.

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% of PHS recommended drinking water standard nitrate concentration zone now includes well 699-31-65 southeast of 200 West Area. The extension of the 10%-100% of PHS Drinking Water Standard zone north of the 300 Area reflects results from new sample wells. There are no major changes in other isopleth contours since the previous report period (July-Dec 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 samples had tritium concentrations less than the analytical limit of 1 pCi/ml and nitrate concentrations less than 1 ppm.

The one exception was well 699-59-80B whose nitrate concentration increased from about 4.5 mg/l to 12 mg/l during this report period. An explanation of this occurrence is still being sought.

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 nitrate 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 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⁾

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.

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 gross beta, tritium and nitrate. Data for these substances from the sample wells in the 200 area and associated 600 area wells appear in Tables 1 and 2. The gross 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 gross alpha, ^{60}Co , ^{90}Sr , ^{137}Cs , and ^{106}Ru in addition to gross beta, ^3H and NO_3^- .

Gross Beta Concentrations (Unconfined Aquifer)

Gross 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 gross 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

* Not including ^3H , whose low energy beta emission does not contribute to the gross 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 .

TABLE 1. Average Gross Beta, Tritium, and Nitrate Ion Concentrations in 600 Area Wells Associated with the 200 Areas

Well No.	Gross Beta (pCi/ml)		Tritium (pCi/ml)		Nitrate (mg/l)	
	July-Dec 1971	Jan-June 1972	July-Dec 1971	Jan-June 1972	July-Dec 1971	Jan-June 1972
Analytical Limit	0.16		1.0		0.5	
Concentration Guide	10		3000		45	
699-S3-E12			*	*	2.3	<1.7
S3-25			*	*	*	*
S6-E4C-0			*	*	*	*
S6-E14-0			*	*	0.6	*
S8-19			*	*	<1.0	1.0
S11-E12-0			*	*	10	9.4
S12-3			*	*	0.7	0.6
S18-E2-0		*			*	
S19-E13		*				4.8
S27-E14					6.4	10
S30-E15A						3.9
S31-1						4.3
1-18			160	170	7.6	5.5
2-3	*		15	17	9.3	7.9
2-33-0				*	*	*
3-45						3.6
8-17	*	*	76	98	22	22
8-25	0.24		300	270	31	24
8-32			*	*	<0.6	*
9-E2			*	*	*	*
10-E12-0					15	0.75
14-E6-T					*	<6.3
14-38-0			*	*	3.8	9.2
15-15 A-0	*	*	4.7	7.8	7.8	8.8
15-26	0.23	0.18	510	410	29	30
17-5			*	*	<1.1	5.9
19-43					1.7	2.2
20-E5-T					*	*
✕ 20-E12-0			*		*	1.1
20-20	0.22	0.26	670	770	45	49
20-39-0			*	<2.7	7.4	<0.6
24-1-T			*	*	<0.6	<0.6
24-33	*	*	420	420	2.2	2.0
24-46			*	*	3.8	3.5
25-70-0					2.5	2.4
26-15	0.61	0.52	1400	1200	55	52
26-89					3.2	*
27-8	*	0.26	965	960	16	32
28-40	*	*	49	49	8.6	6.2
29-78			*	*	1.2	1.0
31-31-0	0.55	0.40	1900	1900	33	24
31-53B-0	*	*	*	*	3.4	6.2
31-65-0			4.5	0.98	*	5.8
32-22	0.36	0.36	1700	1500	39	45
32-43	0.52	0.32		790	36	33
32-62-0	*	*	*	*	<2.7	*

TABLE 1 (contd)

Well No.	Gross Beta (pCi/ml)		Tritium (pCi/ml)		Nitrate (mg/l)	
	July-Dec 1971	Jan-June 1972	July-Dec 1971	Jan-June 1972	July-Dec 1971	Jan-June 1972
Analytical Limit	0.16		1.0		0.5	
Concentration Guide	10		3000		45	
699-32-70	*	*	33.5	34	18	17
32-72-0	*	*	70	71	*	<1.2
32-77	*	*	4	1.7	15	3.3
33-56	*	*	*	*	*	*
34-39A	*	*	2000	2000	4.2	9.2
34-41	0.94	0.72	2200	2000	31	58
34-42	1.0	0.82	2200	2000	140	60
34-51	*	*	*	*	1.9	2.8
34-88-0	*	*	*	*	1.9	1.3
35-9	*	*	24	32	5.6	12
35-66	*	*	*	2.1	*	*
35-70	0.25	*	7200	6550	2.6	1.2
35-78	*	*	1.5	2.2	1.0	0.8
36-46-R	*	*	2200	2100	1.0	2.7
36-61B-0	*	*	*	*	*	<0.6
36-93-0	*	*	*	*	*	*
37-43-0	*	*	75	84	*	*
37-82A-0	*	*	6.0	8.0	10	18
38-65-0	*	*	130	95	17	16
38-70-0	0.89	0.56	*	*	150	91
39-39	<0.65	*	1.8	2.2	*	*
39-79-0	*	*	2.4	*	<1.2	0.97
40-1	*	*	1.0	*	<4.8	*
40-33	*	*	*	*	*	*
40-62	*	*	795	780	12	11
41-23	0.28	*	180	190	50	45
42-12	*	*			18	18
42-42-0						14
43-42	<0.29	*	280	330		*
43-89			*	*	30	26
44-64-0			*	*	12	9.6
45-42						4.2
45-69			<1.1	*	36	32
46-21			*	*	4.7	3.9
47-35			*	*	2.2	1.7
47-46			*	*	12	18
47-60			*	*	6.4	6.0
48-71			*	*	1.9	2.1
49-28			*	*	*	*
49-55	*	*	*	*	*	*
49-57			7.2	1.6	1.6	1.8
49-79			*	*	33	25
50-28	*	*	*	*	4.2	4.6
50-42-0			*	*	*	*
50-53	0.33	0.35	1.7	1.3	36	14
50-85					11	11

TABLE 1 (contd)

Well No.	<u>Gross Beta (pCi/ml)</u>		<u>Tritium (pCi/ml)</u>		<u>Nitrate (mg/l)</u>	
	<u>July-Dec 1971</u>	<u>Jan-June 1972</u>	<u>July-Dec 1971</u>	<u>Jan-June 1972</u>	<u>July-Dec 1971</u>	<u>Jan-June 1972</u>
Analytical Limit	0.16		1.0		0.5	
Concentration Guide	10		3000		45	
699-51-63			*	*	1.2	1.2
53-47			3.3	2.6	*	*
53-55-0			1.6	1.8	*	*
54-42			*	*	3.6	3.5
54-45				*		*
54-57			*	*	*	*
55-21					1.6	1.7
55-50A			2.1	2.6	*	1.4
55-70-0					<0.6	*
55-76-0					*	*
55-89-0					*	*
55-95					<0.8	1.9
57-83-0					*	*
59-80B					4.8	12
HAN-6				*	1.6	2.6
HAN-9					2.4	3.0
HAN-19			*	*	2.1	1.8

Gross 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 2. (contd)

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

Well No. (299-)	Gross Beta (pCi/ml)		^{60}Co (pCi/ml)		NO_3^- (mg/l)		^{106}Ru (pCi/ml)	
	July-Dec 1971	Jan-June 1972	July-Dec 1971	Jan-June 1972	July-Dec 1971	Jan-June 1972	July-Dec 1971	Jan-June 1972
Analytical Limit	0.16		0.03		0.5		0.1	
Concentration Guide	10		20		45		10	
E24-9	1.1	1.2			230	325		
E26-1	3.5	*	*				1.7	
E26-4	3.4	2.3				36	1.6	0.99
E33-9	9.0	9.4						
E33-18	1.1	0.68						
E33-25	2.5	0.81			273	47		
E33-26	1.1	0.99						
E33-27	21.3	11.			*	<0.6		
W11-15	4.0	2.7	*	*			2.0	1.2
W11-17	1.0	0.68	*	*	365	245	0.43	0.24
W14-2	11.3	7.9	0.06	0.046	637	570	6.03	3.3
W15-7	3.2	2.1	3.03	2.3	57	72	*	
W22-1	40	45				1.5		
W22-13	4.0	2.1	*	*		6.4	1.83	0.90
W22-21	28	36						
W22-26	230	153	0.37	0.34	200	190	120	76

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

Part A: Wells Near Active Crib Sites, Ponds, Ditches

Well No. (299-)	Gross Beta (pCi/ml)		^{60}Co (pCi/ml)		NO_3^- (mg/l)		^{106}Ru (pCi/ml)	
	July-Dec 1971	Jan-June 1972	July-Dec 1971	Jan-June 1972	July-Dec 1971	Jan-June 1972	July-Dec 1971	Jan-June 1972
Analytical Limit	0.16		0.03		0.5		.10	
Concentration Guide	10		20		45		10	
E16-2	1.6	1.6			1.8	24		
E17-1	0.95	0.73	0.19	0.14	93	93	0.18	0.18
E17-4	2.0	1.5	0.13	0.19			0.70	0.49
E17-5	2.4	1.2	0.18	0.11	255	195	1.2	0.54
E17-6	<0.23	*						
E17-7	1.9	1.6	0.13	0.15	268	250	0.88	0.71
E17-9	7.9	6.1	*	*			4.03	3.10
E17-10	2.1	1.4						
E24-2	0.99	0.67	0.05	0.04	200	200	0.37	0.26
E25-5	0.36	0.73						
E25-6	0.27	0.36	*	*	56	41	0.16	0.12
E25-9	*	*						
E25-11	1.4	1.8	*	*			0.71	0.79
E25-12	0.74	0.92						
E28-9	0.29	0.34	*	*	219	170	0.14	0.18
E28-12	*	*	*	*			*	*
E28-13	<0.17	<0.21	*	*	77	71	*	*
E28-16				*	300	385	0.13	0.11
E28-17	<0.19	<0.23						
E33-7	5.8	7.8	5.8	9.0			0.37	0.17
E33-23	2.0	1.1	0.36	0.32	9.7	5.7	0.19	*
E34-1						8.6		
W15-4	0.40	0.31	*	*	238	167	0.26	.14
W15-10	*	*				1.0		
W15-11	*	*						
W18-1	*	*						
W18-2	*	*						
W18-4	*	*						
W18-5	*	*			*	*		
W18-10	*	*						
W18-11		*						
W18-12		*						
W19-5	72	36	*	*	84	58	36	17
W19-7	<0.97	*						
W22-22	1.5	1.3			*	*		
W22-38	*	*						
W26-3	0.20	*	*	*	3.6	3.5	0.11	*

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 not used to illustrate it.

A comparison of the CG isopleths for the six-month periods ending Dec 1971 and June 1972 indicates only a few minor adjustments. Well 299-E26-1 is now below detection limit for gross beta. In general the gross beta concentration levels are declining, particularly at the outer contour of the contamination plumes.

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 December 1971, and June 1972, indicates that no major changes have occurred. There was no significant detectable movement of the 200 East Area plume in the southeasterly direction.

Nitrate Ion Concentrations (Unconfined Aquifer)

Nitrate ion 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 December 1971 and June 1972 indicates that a few changes in the 10% drinking water standard isopleth occurred. The most significant changes in the nitrate contamination pattern are 1) the appearance of nitrate in well 699-31-65 southeast of 200 West Area during this period; 2) an increase of 5 mg/l nitrate under the FFTF area; and 3) intermittent observed concentration levels of up to 11 mg/l nitrate in well 699-17-5. The conversion at

the FFTF site during this period to the permanent water supply wells 699-S0-7 and S0-8 which tap the unconfined aquifer gave new data for contamination levels in the 200 East area plume. It was not possible to determine from available data whether the nitrate plume above the 10% of drinking water standard extended to well 699-17-5 during the January-June 1972 period.

Other minor changes are due to reinterpretation of the contamination pattern in the vicinity of well 699-39-79 and adjacent 299 wells to reflect the fact that nitrate concentration levels in this area are below 4.5 mg/l (10% of drinking water standard) and a reduction of average nitrate concentrations in wells 299-E25-6 and 699-42-42-0 to the 10-100% level of drinking water standard.

Other Radionuclides (Unconfined Aquifer)

Certain wells in parts of the 600 area associated with 200 area disposal operations were also analyzed for ^{60}Co , ^{106}Ru , and ^{137}Cs . The only results above the detection limit are average concentrations of ^{60}Co from .10 to .14 pCi/ml in wells 699-26-15, -31-31-0, and -50-53.

Table 2 contains the results of gross beta, ^{60}Co , and ^{106}Ru concentration measurements in the (200) Chemical Separations Areas. The higher concentration levels of these radionuclides are listed by disposal site in Table 6, along with results from the previous reporting period. Most of the gross beta activity above the concentration guide is at inactive disposal sites in the 200 West Area. No sites had ^{60}Co average concentration above the concentration guide (20 pCi/ml). As expected, the highest concentration levels of ^{106}Ru were in 200 West Area at the same sites as the highest gross beta activity.

Detectable concentrations of gross alpha, ^{137}Cs and ^{90}Sr for this report period are listed by disposal site in Table 3. Tables 4 and 5 show the active and cited inactive disposal sites along with associated groundwater sampling wells. Average concentration trends are indicated by comparison with results from the previous reporting period.

No significant changes in concentration levels of gross alpha, ^{137}Cs or ^{90}Sr occurred during January-June 1972. The alpha activity at the 216-S-13 crib was due entirely to an average uranium concentration of 1.8 pCi/ml (with a CG of 20 pCi/ml), as has been the case in the past.

TABLE 3. Detectable Concentrations of Other Radionuclides in the Unconfined Groundwater Under the 200 Areas Listed by Disposal Site

			Average Concentration (pCi/ml)		Analytical Limit	Concentration Guide
Site			July- Dec 71	Jan- June 72		
Gross Alpha					0.02	5
216-S-13	I		1.97	1.41		
S-21	I		0.07	0.07		
A-27	I		0.06	0.04		
B-10-B	A		0.03	*		
¹³⁷ Cs					0.03	20
216-B46,50	A,I		0.78	0.64		
216-A-24	I		0.033	0.076		
216-S-9	I		<0.10	<0.07		
⁹⁰ Sr					0.03	0.3
216-S-1	I		19.7	19.2		
216-S-2	I		0.17	0.15		
216-A-36-B	A		0.067	0.064		
216-A-5	I		0.033	<0.032		
216-A-10	A		0.03	<0.032		

Gross Alpha concentrations are calibrated for ²³⁹Pu.

A denotes active disposal site.

I denotes inactive disposal site.

TABLE 4. Active Disposal Sites--Cribs, Ditches, Ponds, Swamps200 East Area
Site DesignationPurexAssociated Sample Wells

216-A-8	299-E25-4, -E25-5, -E25-6, -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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TABLE 4. (contd)

<u>200 West Area Site Designation</u>	<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
<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-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
216-Z-19	-----

TABLE 5. 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
241-BY-1,2	299-E33-9
<u>200 West Area Site Designation</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
216-T-26	299-W14-1, -W14-2, -W14-3
216-Z-7	299-W15-7

TABLE 6. Highest Gross Beta, ^{60}Co , ^{106}Ru , Concentrations Under the 200 Areas Listed by Disposal Site

		Average Concentration (pCi/ml)		Concentration Guide
		July-Dec 71	Jan-June 72	
Gross Beta				10
	Active Sites			
	216-S-23	72	36	
	216-B-56	5.8	7.8	
	A-36B	7.9	6.1	
	B-57	5.4	3.6	
	Inactive Sites			
	216-S-9	230	153	
	S-1	40	45	
	S-13	28	36	
	241-BX-1,2	21	11	
	241-By-1,2	9.0	9.4	
^{60}Co				20
	Active Sites			
	216-B-50	5.8	9.0	
	B-57	3.5	2.4	
	Inactive Sites			
	216-Z-7	3.0	2.3	
^{106}Ru				10
	Active Sites			
	216-S-23	36	17	
	216-A-36B	4.0	3.1	
	Inactive Sites			
	216-S-9	120	76	
	216-T-26	6.0	3.3	

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 tritium 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 less than 0.65 and 1.2 mg/l were observed in wells 699-36-61B-P and 699-38-65-P, respectively. The values for these wells which lie between the 200 East and 200 West Areas are essentially unchanged from previous report periods.

From March 1971 through June 1972 the nitrate concentration in well 699-59-80B south of Gable Buttes increased from about 4.5 mg/l to 15 mg/l. The source of this increase is unknown at this time. It is possible that this well taps part of the confined aquifer due to its proximity to Gable Buttes. The matter is under further investigation.

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. Table 7 contains the observed average concentrations of gross beta, tritium, and nitrate ion in 100 Area and associated 600 area wells. Some groundwater samples in the 100-N area were analyzed for ^{60}Co , ^{40}Sr , ^{106}Ru and ^{137}Cs . Average measured concentrations of these radionuclides are presented in Table 8.

TABLE 7. Average Gross Beta, Tritium and Nitrate Concentrations in 100 Area and Associated 600 Area Wells

Well No.	Gross Beta (pCi/ml)		Tritium (pCi/ml)		Nitrate (mg/l)	
	July-Dec 1971	Jan-June 1972	July-Dec 1971	Jan-June 1972	July-Dec 1971	Jan-June 1972
Analytical Limit	0.16		1.0		0.5	
Concentration Guide	10		3000		45	
199-B4-4	*	*	5.0		1.0	
D2-5			9.3		57	33
D5-12	0.30	*	8.4	6.5	42	25
F5-1			*	*	<1.2	0.6
F8-1			16.5	19	54	54
H3-1			18.0	17	8.8	12
K-11			105	98	*	*
K-20	*	*	7.8	8.8	<0.6	
N-3-0	1.0	3.7	500	1320		
N-4-0	*	*	53	729	*	4.8
N-10-0	1.6	3.0	106	1450		
699-59-33					*	*
60-60			*	1.5	<0.65	0.83
61-66			*	*	3.4	2.4
62-32					3.4	5.0
62-43F					<0.7	*
63-25					<0.6	<0.6
63-90				*	3.4	3.1
65-50			*	*	0.7	*
65-59			1.6		0.7	
65-72			1.6	*	*	*
65-83			2.9	1.8	0.7	0.8
66-23-0					*	*
66-38					<0.6	*
67-51-0			*	*	2.0	<0.77
67-86			4.3	2.9	1.4	1.0
67-98			1.3	*	2.4	2.0
69-38				*	18	49
69-45-0			*	*	*	*
70-68			1.1	*	2.2	1.4
71-30			*	*	16	16
71-52			5.5	5.4	5.7	5.2
71-77			2.1	*	2.5	1.4
72-73			4.4	3.2	3.4	2.6
72-88			19.5	17	*	*
72-92-0			23	22	3.2	2.3
72-98			14		*	*
74-44			*		*	*
74-48			1.3	1.6	2.4	2.7
77-36			*	*	120	160
77-54			*	*	4.8	4.6
80-43S			*	*	<0.9	0.9
81-58-0			<1.1	11.	1.4	1.4
83-47-0			*	*	*	*
84-35			2.4	*	9.9	4.6
86-60	0.33	0.40	180	810	6.4	6.1

TABLE 7. (contd)

Well No.	Gross Beta (pCi/ml)		Tritium (pCi/ml)		Nitrate (mg/l)	
	July-Dec 1971	Jan-June 1972	July-Dec 1971	Jan-June 1972	July-Dec 1971	Jan-June 1972
Analytical Limit	0.16		1.0		0.5	
Concentration Guide	10		3000		45	
699-87-42			*	1.1	0.8	0.7
87-55			24	36	5.1	6.0
89-35			*	*	4.4	5.2
90-45			62	52	*	*
96-49-0			23	7.0	2.7	<1.5
97-43-0			8.5	12	7.3	8.0

Gross 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 8. Other Radionuclides Observed in the Groundwater in the Vicinity of 100-N Area.

	^{60}Co (pCi/ml)		^{90}Sr (pCi/ml)		^{51}Cr (pCi/ml)		^{106}Ru (pCi/ml)		^{137}Cs (pCi/ml)	
	July-Dec 71	Jan-June 72	July-Dec 71	Jan-June 72	July-Dec 71	Jan-June 72	July-Dec 71	Jan-June 72	July-Dec 71	Jan-June 72
Analytical Limit	0.03		0.03		0.5		0.12		0.03	
Concentration Guide	30		0.3		2000		10		20	
100-N Area:										
199-N-3-0	0.056	0.054		0.12	1.7		0.13	0.18	0.03	*
N-4-0		0.034		*				*		*
N-10-0	*	*		0.8	*		*	0.15	*	
699-86-60	0.05									

Gross Beta Concentrations (Unconfined Aquifer)

The estimated extent of detectable gross 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 December 1971 and June 1972 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-3-0 (3.7 pCi/ml). This is an increase of 370% from the previous report 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 two zones as shown in Figure 2.

The extent of the 10-100%CG and the 1-10% CG zones in the 100 N Area has increased reflecting changes in the average tritium concentrations in the wells monitoring the 1301-N crib. The increased tritium concentration levels discharged to this crib are due to cladding removal operations from the tritium bearing target elements for the N reactor co-product program.

Other minor changes in the 100 areas tritium contamination pattern are due to seasonal river fluctuations and their diluting effect during periods of riverbank recharge. Tritium concentration levels in well 699-60-60 averaged 1.5 pCi/ml, just above the analytical limit. Additional data is being collected to determine whether the tritium contamination zone under the 100 F Area should be connected to that around 100 N Area.

Nitrate Ion Concentrations (Unconfined Aquifer)

There were no significant changes in the nitrate contamination zone contours in the vicinity of the 100 Areas during this report period. 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 former 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 $^{106}\text{Ru-Rh}$ have also been identified on occasion, as mentioned in previous reports. The results of 300 Area well sampling are presented in Table 9. 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. Its average total beta concentration decreased 75% since July-December 1971.

The concentration of nitrate ion in much of the groundwater beneath the 300 Area (Table 9) is above the Public Health Service drinking water limit⁽⁴⁾ of 45 ppm. New observation wells around the 300 Area have shown the 10-100% of drinking water standard nitrate concentration zone to be extended slightly to the south and significantly to the north of the 300 Area as shown in Figure 3. Well 699-S11-E12 which has shown detectable nitrate since January 1971 is now assumed to be included in the 300 Area nitrate plume since new well 699-S19-E13 also shows nitrate concentrations above the 10% of drinking water standard. The zone of nitrate contamination above the drinking water standard (45 mg/l) is primarily in the vicinity of the North Process Pond which is the prime source of nitrate in the 300 Area groundwater.

TABLE 9. Analytical Data - 300 Area and Associated 600 Area Wells

Well No.	Gross Beta (pCi/ml)		Nitrate (mg/l)		Gross Alpha (pCi/ml)		Cr ⁺⁶ (ug/l)		F ⁻ (mg/l)	
	July- Dec 71	Jan- June 72	July- Dec 71	Jan- June 72	July- Dec 71	Jan- June 72	July- Dec 71	Jan- June 72	July- Dec 71	Jan- June 72
Analytical Limit	0.16		0.5		0.02		3		0.2	
Concentration Guide	10		45		5		50		1.5	
699-S19-E13		*		4.8		*		<3.4		0.3
S27-E14			6.4	10	*	*	<3	4.8	0.26	0.28
S29-E12				*		*				0.3
S30-E15A				<3.9		*				*
399-1-1	0.25	<0.21	35	42	0.05	<0.03	<15	<4.6	1.2	1.1
1-2	<0.17	*	22	52	0.084	0.06	<3.2	<4.0	1.2	1.0
1-3	*	<0.22	64	118	0.11	0.10	4.5	8.4	1.2	2.2
1-4	*	*	14	26	0.07	0.04	<2.8	<4.2	0.7	0.92
3-1	*	*	30	74	0.096	0.05	2.9	<3.2	1.0	0.99
3-8	2.9	12	32	21	0.054	0.05	<2.8	<3.1	1.3	0.93
4-1	*	*	28	11	0.11	0.06	2.8	<3.5	1.0	0.98
4-7	*	*	42	29	0.15	0.09	3.9	<4.4	1.2	1.2
4-8		*		15		0.05		<4.2		0.6
5-1			15	12	*	0.02	2.8	<3.2	0.3	0.32
6-1			10	11	<0.023	0.02	4.4	3.9	0.3	0.31
8-2			5.9	6.2	*	*	<3.3	<3.6	0.27	0.28
8-3			12	5.7	*	*	<2.9	<3.2	0.4	0.33

Gross Beta is calculated as ¹⁰⁶Ru-Rh.

Gross 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.

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