
5.2 Air Surveillance

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Atmospheric releases of pollutants from Hanford to the surrounding region are a potential source of human exposure. For that reason, both radioactive and nonradioactive materials in air are monitored at a number of locations. The influence of Hanford emissions on local radionuclide concentrations was evaluated by comparing concentrations measured at distant locations within the region to concentrations measured at the Site perimeter. This section discusses sample collection, analytical methods, and the results of the Hanford air surveillance program. A complete listing of all analytical results summarized in this section is reported separately by Bisping (1995).

Sample Collection and Analysis

Radiological Air Sampling

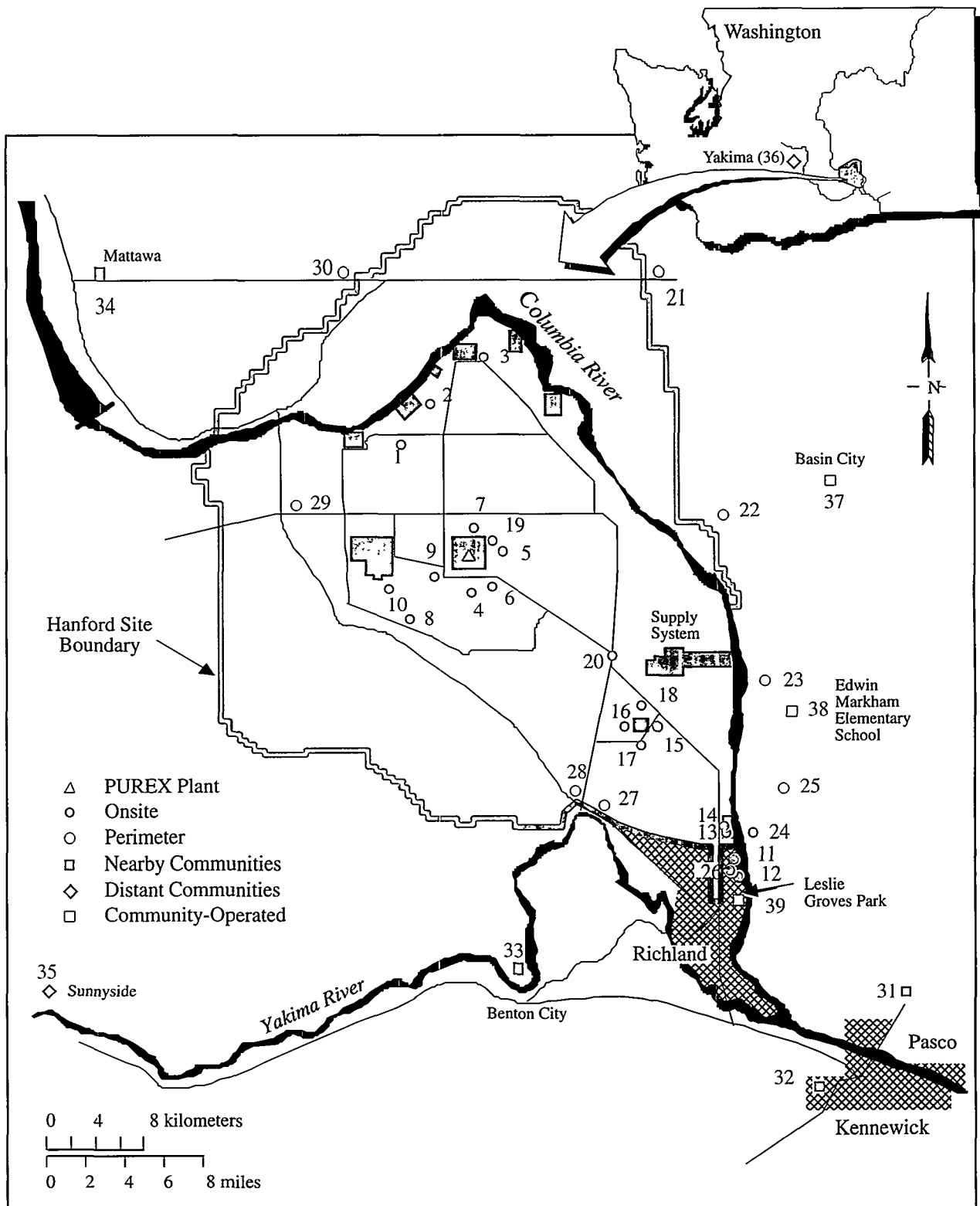
Airborne radionuclides were sampled by a network of 39 continuously operating samplers: 20 on the Hanford Site, 10 near the Site perimeter, 4 in nearby communities, 2 in distant communities, and 3 community-operated environmental surveillance stations that were managed and operated by local school teachers (Figure 5.2.1 and Table 5.2.1). Air samplers on the Hanford Site were located primarily around major operational areas to maximize the ability to detect contaminants resulting from Site operations. Perimeter samplers were located around the Site, with emphasis on the prevailing downwind directions to the south and east of the Site. Continuous samplers located in Benton City, Richland, Kennewick, Mattawa, and Pasco provided concentrations at the nearest population centers. Samplers at the distant communities of Sunnyside and Yakima provided background data from communities essentially unaffected by Site operations.

Samples were collected according to a schedule established before the monitoring year (Bisping 1994). Air sampling locations are listed in Table 5.2.1, along with specific analyses for each location.

Airborne particles were sampled at each of these locations by continuously drawing air through a high-efficiency glass-fiber filter. The filters were collected every 2 weeks, field surveyed with handheld instruments for total radioactivity to detect for unusual occurrences, and stored for at least 7 days at the analytical laboratory. The storage period was necessary to allow for the decay of short-lived, naturally occurring radionuclides (e.g., radon gas decay products) that would otherwise obscure detection of longer-lived radionuclides potentially present from Hanford emissions. The filters were then analyzed for total beta radioactivity and most filters were also analyzed for total alpha radioactivity. Field measurements of radioactivity in samples are used to monitor changes in environmental conditions that could warrant attention before the more detailed and sensitive laboratory analyses are completed.

For most radionuclides, the amount of radioactive material collected on the filter during the 2-week period was too small to be readily measured. The sensitivity and accuracy of sample analysis was increased by combining biweekly samples for nearby locations (or in some cases a single location) into quarterly composite samples. The quarterly composite samples were analyzed for numerous specific gamma-emitting radionuclides (Appendix F). The quarterly composite samples were then combined to form annual composite samples (Table 5.2.1). Annual composites were analyzed for strontium and plutonium isotopes, and selected annual composites were also analyzed for uranium and americium isotopes.

Gaseous iodine-131 was sampled at four locations by drawing air through a cartridge containing chemically treated activated charcoal. These cartridges were exchanged biweekly and were located downstream of a particle filter. Iodine-131 has a short half-life (8 days) and is potentially present in the environment only around active nuclear reactors.



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Figure 5.2.1 Air Sampling Locations, 1994

Table 5.2.1 Air Sampling Locations, Sample Composite Groups, and Analyses, 1994

Location ^(a)	Sampling Location	Analyses ^(b)	Composite Group	Analyses ^(c)
Onsite				
1	100-K	Beta, alpha, ³ H	} 100 Areas	Gamma, Sr, Pu
2	100-N, 1325 Crib	Beta, alpha, ³ H		
3	100-D	Beta, alpha		
4	S of 200-East	Beta, alpha	} 200 East	Gamma, Sr, Pu, U, Am
5	E of 200-East	Beta, alpha		
6	200-East SE	Beta, alpha, ³ H, ¹²⁹ I		
7	N of 200-East	NRA ^(d)		
8	Army Loop Camp	Beta, alpha	} 200-West, South, and East	Gamma, Sr, Pu, U
9	GTE Building	Beta, alpha, ³ H		
10	200-West SE	Beta, alpha, VOC ^(e)	200-West	Gamma, Sr, Pu, U
11	300 Water intake	Beta	} 300 Area	Gamma, Sr, Pu, U
12	300-South Gate	Beta, alpha, ³ H		
13	300 NE	Beta, alpha, ³ H, VOC	} 300 NE	Gamma, Sr, Pu, U
14	300 Trench	Beta, alpha, ³ H		
15	400-East	Beta, alpha, ³ H	} 400 Area	Gamma, Sr, Pu
16	400-West	Beta, alpha		
17	400-South	Beta, alpha		
18	400-North	Beta, alpha		
19	B Pond	Beta, alpha	B Pond	Gamma, Sr, Pu, U
20	Wye Barricade	Beta, alpha	Wye Barricade	Gamma, Sr, Pu, U, Am
Perimeter				
21	Berg Ranch	NRA		
22	Ringold Met. Tower	Beta, alpha, ³ H, ¹²⁹ I, ¹³¹ I	Ringold Met. Tower	Gamma, Sr, Pu
23	W End of Fir Road	Beta, alpha	W End of Fir Road	Gamma, Sr, Pu, U, Am
24	Byers Landing	Beta, alpha, ³ H, ¹²⁹ I, ¹³¹ I	Byers Landing	Gamma, Sr, Pu, U, Am
25	Dogwood Met. Tower	Beta, alpha, ³ H	Dogwood Met. Tower	Gamma, Sr, Pu, U, Am

Table 5.2.1 Air Sampling Locations, Sample Composite Groups, and Analyses, 1994 (contd)

Location ^(a)	Sampling Location	Analyses ^(b)	Composite Group	Analyses ^(c)
26	Battelle Complex	NRA		
27	Horn Rapids Road Substation	Beta, alpha	} Prosser Barricade	Gamma, Sr, Pu, U
28	Prosser Barricade	Beta, alpha, ³ H		
29	Yakima Barricade	Beta, alpha, VOC ^(f)	Yakima Barricade	Gamma, Sr, Pu
30	Wahluke Slope	Beta, alpha, ³ H	Wahluke Slope	Gamma, Sr, Pu
Nearby Communities				
31	Pasco	Beta	} Tri-Cities	Gamma, Sr, Pu
32	Kennewick	Beta, alpha		
33	Benton City	NRA		
34	Mattawa	NRA		
Distant Communities				
35	Sunnyside	Beta, alpha, ³ H	Sunnyside	Gamma, Sr, Pu, U
36	Yakima	Beta, alpha, ³ H, ¹²⁹ I, ¹³¹ I	Yakima	Gamma, Sr, Pu, U, Am
Community-Operated Environmental Stations				
37	Basin City	Beta, alpha, ³ H	Basin City Elem. School	Gamma, Sr, Pu, U
38	North Franklin County	Beta, alpha, ³ H, ¹³¹ I	Edwin Markham Elem. School	Gamma, Sr, Pu, U, Am
39	Richland	Beta, alpha, ³ H	Leslie Groves Park	Gamma, Sr, Pu, U

(a) See Figure 5.2.1.

(b) Beta, alpha, and ¹³¹I samples are collected biweekly (every 2 weeks), ³H samples are collected monthly (every 4 weeks), and ¹²⁹I samples are collected monthly (every 4 weeks) and combined into a quarterly composite sample for each location (see Sample Collection and Analysis in this section).

(c) Gamma scans are performed on quarterly composite samples; Sr, Pu, U, and Am analyses are performed on annual composite samples (see Sample Collection and Analysis in this section).

(d) NRA = not routinely analyzed.

(e) VOC = Volatile organic compounds.

(f) The volatile organic compounds samples were collected at Rattlesnake Springs.

With the shutdown of all DOE nuclear reactors on the Hanford Site, there is no active DOE source of this radioisotope, any iodine-131 released to the environment from past operations would have decayed to undetectable amounts. Therefore,

sampling for iodine-131 on the Hanford Site was discontinued in 1993. Iodine-131 was sampled at four locations offsite to maintain field sampling and analytical capability.

Iodine-129 (16,000,000-year half-life) was sampled using a similar technique as that used to collect iodine-131; however, a special low-background petroleum-charcoal cartridge was used for increased sensitivity. Samples were collected monthly at four locations and combined to form quarterly composite samples for each location.

Atmospheric water vapor was collected for tritium analysis at 18 locations by continuously passing air through cartridges containing silica gel, which were exchanged every 4 weeks. The collected water was distilled from the silica gel and analyzed for its tritium content.

A detailed description of all radiological sampling and analytical techniques is provided in the *Hanford Site Environmental Monitoring Plan* (DOE 1991b). Air samples were collected, but not routinely analyzed, at Benton City, the Battelle complex, Berg Ranch, Mattawa, and north of the 200-East Area. Samples from these locations were stored in an archive facility in the event that later analysis would be required in case of an unusual occurrence on the Site.

A portion of the environmental surveillance air samples was collected at three community-operated environmental surveillance stations located at Basin City Elementary School in Basin City, Edwin Markham Elementary School in North Franklin County, and Leslie Groves Park in Richland (see Figure 5.2.1 and Table 5.2.1). These samples were collected by local teachers using the same equipment, procedures, and analytical laboratory as the routine surveillance program. This work is part of an ongoing DOE-sponsored program to promote public awareness of Hanford environmental monitoring programs and the effects of Site operations.

Nonradiological Air Sampling

Samples for volatile organic compounds in air were collected downwind of the 300 Area Process Trenches (Table 5.2.1, location #13), at the southeast corner of the 200-West Area (Table 5.2.1, location #10), and at a background location near Rattlesnake Springs (Table 5.2.1, near location #29). Air samples for volatile organic compounds were collected using EPA Method TO-2 (EPA 1988), which uses low-volume air samplers with adsorbent (carbon molecular sieve) traps. Air samples were

analyzed by the Hanford Environmental Health Foundation using thermal desorption techniques and gas chromatography-mass spectrometry.

Results

Radiological Results

Radiological air sampling results for onsite, Site perimeter, nearby communities, distant communities, and community-operated stations for total beta, total alpha, and specific radionuclides are summarized in Table 5.2.2. Numerous specific radionuclides (Appendix F) were identified in the quarterly composite gamma-scan analyses, but none of Hanford origin was detected consistently.

Total beta concentrations in air for 1994, as shown in Figure 5.2.2, peaked during the winter, repeating a pattern of natural annual radioactivity fluctuations (Eisenbud 1987). As shown in Table 5.2.2, the average total beta concentrations were about the same onsite as at the Site perimeter and in nearby and distant communities, indicating that the observed levels were predominantly a result of natural sources and worldwide radioactive fallout.

The concentrations of total alpha radioactivity in air for 1994 are given in Table 5.2.2. The average concentration of total alpha radioactivity at the Site perimeter and nearby communities in 1994 was elevated compared to the concentrations measured at the distant stations; however, the concentrations were not beyond the range of 1992 to 1993 measurements as shown in Figure 5.2.3.

The airborne concentration of tritium from 1989 to 1994 is given in Table 5.2.3. Table 5.2.3 provides a consistent treatment of the historical data because previous Hanford Site reports used differing methods to report suspect tritium results. As shown in Table 5.2.3, tritium concentrations measured in 1994 were similar to the values reported from 1989 and 1990 and did not show the highly elevated concentrations and widely variable results reported for 1991 and 1992 (Woodruff et al. 1993). The 1991 and 1992 results are highly suspect and are likely the results of cross-contamination because even the concentrations at the distant locations were high and variable. Tritium concentrations for two individual samples for 1994 were elevated (two of 231 samples were ≥ 100 pCi/m³) and were also suspected as resulting from cross-contamination; however, no sampling

Table 5.2.2 Airborne Radionuclide Concentrations in the Hanford Environs, 1994 Compared to Values from the Previous 5 Years

Radionuclide	Location Group ^(a)	No. of Samples	1994		No. of Samples	1989–1993		1994
			Maximum ^(b)	Average ^(c)		Maximum ^(b)	Average ^(c)	Concentration Guide ^(d)
			pCi/m ³	pCi/m ³		pCi/m ³	pCi/m ³	pCi/m ³
Total Beta	Onsite	469	0.047 ± 0.0063	0.017 ± 0.00072	2487	0.13 ± 0.012	0.020 ± 0.00052	
	Perimeter	180	0.041 ± 0.0046	0.016 ± 0.0011	1471	0.15 ± 0.014	0.019 ± 0.00065	
	Nearby Communities	52	0.050 ± 0.0052	0.018 ± 0.0026	767	0.10 ± 0.0098	0.019 ± 0.00091	
	Distant Communities	51	0.095 ± 0.0099	0.016 ± 0.0037	492	0.12 ± 0.013	0.017 ± 0.00099	
	COES Stations ^(e)	78	0.038 ± 0.0054	0.016 ± 0.0019	212	0.079 ± 0.0082	0.019 ± 0.0017	
				aCi/m ³	aCi/m ³		aCi/m ³	aCi/m ³
⁹⁰ Sr	Onsite	9	14 ± 58	-14 ± 14	116	4200 ± 810	83 ± 98	9,000,000
	Perimeter	7	29 ± 78	-21 ± 24	73	2300 ± 430	130 ± 110	
	Nearby Communities	1	-32 ± 50	-32 ± 50	47	6300 ± 1200	210 ± 290	
	Distant Communities	2	68 ± 120	46 ± 44	44	52 ± 33	-6.5 ± 5.8	
	COES Stations	3	5.1 ± 54	-7.7 ± 17	15	64 ± 39	-1.3 ± 14	
¹⁰⁶ Ru	Onsite	36	3200 ± 2400	-290 ± 520	284	14,000 ± 9500	-210 ± 500	30,000,000
	Perimeter	28	7400 ± 4500	-110 ± 890	208	17,000 ± 19,000	180 ± 580	
	Nearby Communities	4	980 ± 2600	-970 ± 2000	133	12,000 ± 11,000	-260 ± 940	
	Distant Communities	8	5000 ± 3500	280 ± 2100	121	20,000 ± 16,000	160 ± 970	
	COES Stations	12	5300 ± 4100	730 ± 1200	33	2400 ± 3400	-370 ± 500	

Table 5.2.2 Airborne Radionuclide Concentrations in the Hanford Environs, 1994 Compared to Values from the Previous 5 Years (contd)

Radionuclide	Location Group ^(a)	1994			1989-1993			1994
		No. of Samples	Maximum ^(b)	Average ^(c)	No. of Samples	Maximum ^(b)	Average ^(c)	Concentration Guide ^(d)
			aCi/m ³	aCi/m ³		aCi/m ³	aCi/m ³	
¹²⁹ I	Onsite	4	43 ± 4.3	37 ± 9.3	20	110 ± 11	55 ± 12	70,000,000
	Perimeter	8	2.2 ± 0.18	1.2 ± 0.37	40	5.2 ± 0.39	1.7 ± 0.31	
	Distant Communities	4	0.085 ± 0.0065	0.065 ± 0.014	20	0.40 ± 0.046	0.13 ± 0.042	
¹³¹ I	Perimeter	51	5700 ± 4100	550 ± 540	406	13,000 ± 11,000	-260 ± 260	400,000,000
	Distant Communities	24	4500 ± 3300	160 ± 1200	187	7200 ± 8900	2.1 ± 270	
	COES Stations	25	6700 ± 5700	340 ± 1000	164	28,000 ± 19,000	430 ± 500	
¹³⁷ Cs	Onsite	36	360 ± 300	51 ± 59	284	1200 ± 880	53 ± 47	400,000,000
	Perimeter	28	380 ± 250	30 ± 77	208	1400 ± 1100	-24 ± 64	
	Nearby Communities	4	340 ± 210	100 ± 190	133	1600 ± 1100	38 ± 91	
	Distant Communities	8	360 ± 400	80 ± 130	121	1300 ± 1200	40 ± 90	
	COES Stations	12	340 ± 260	-41 ± 150	33	390 ± 280	21 ± 48	
U Total ^(f)	Onsite	7	190 ± 280	66 ± 44	85	6200 ± 400	200 ± 160	100,000
	Perimeter	4	62 ± 13	51 ± 13	30	120 ± 20	68 ± 8.6	
	Distant Communities	2	52 ± 8.7	37 ± 31	29	250 ± 30	58 ± 17	
	COES Stations	3	73 ± 21	60 ± 16	15	87 ± 17	56 ± 9.1	

Table 5.2.2 Airborne Radionuclide Concentrations in the Hanford Environs, 1994 Compared to Values from the Previous 5 Years (contd)

Radionuclide	Location Group ^(a)	1994			1989-1993			1994
		No. of Samples	Maximum ^(b)	Average ^(c)	No. of Samples	Maximum ^(b)	Average ^(c)	Concentration Guide ^(d)
			aCi/m ³	aCi/m ³		aCi/m ³	aCi/m ³	aCi/m ³
²³⁸ Pu	Onsite	9	0.68 ± 2.2	-0.44 ± 0.43	116	2.7 ± 2.1	0.36 ± 0.13	30,000
	Perimeter	7	3.1 ± 4.1	-0.19 ± 1.2	72	3.0 ± 2.5	0.043 ± 0.15	
	Nearby Communities	1	-0.0076 ± 0.90	-0.0076 ± 0.90	47	0.84 ± 1.3	-0.069 ± 0.097	
	Distant Communities	2	0.86 ± 3.5	0.84 ± 0.039	44	5.3 ± 3.1	0.34 ± 0.33	
	COES Stations	3	0.76 ± 3.3	-0.32 ± 1.2	15	1.8 ± 1.6	0.29 ± 0.26	
^{239/240} Pu	Onsite	9	3.0 ± 3.1	1.2 ± 0.76	116	86 ± 14	2.5 ± 1.7	20,000
	Perimeter	7	1.1 ± 2.5	0.30 ± 0.38	72	2.5 ± 2.0	0.65 ± 0.18	
	Nearby Communities	1	0.24 ± 1.7	0.24 ± 1.7	47	2.2 ± 1.6	0.48 ± 0.20	
	Distant Communities	2	-0.14 ± 1.5	-0.22 ± 0.15	44	3.9 ± 1.3	0.41 ± 0.31	
	COES Stations	3	1.3 ± 3.1	-0.20 ± 1.5	15	3.3 ± 1.5	1.3 ± 0.48	
²⁴¹ Am ^(g)	Onsite	2	0.50 ± 1.5	0.46 ± 0.077	2	0.90 ± 1.2	0.41 ± 0.98	20,000
	Perimeter	3	-0.078 ± 3.2	-0.64 ± 0.72	2	0.43 ± 1.2	0.28 ± 0.31	
	Distant Communities	1	-1.1 ± 3.4	-1.1 ± 3.4	1	-0.47 ± 1.1	-0.47 ± 1.1	
	COES Stations	1	-0.64 ± 3.4	-0.64 ± 3.4	1	-0.32 ± 0.76	-0.32 ± 0.76	

Table 5.2.2 Airborne Radionuclide Concentrations in the Hanford Environs, 1994 Compared to Values from the Previous 5 Years (contd)

Radionuclide	Location Group ^(a)	1994			1989–1993			1994
		No. of Samples	Maximum ^(b)	Average ^(c)	No. of Samples	Maximum ^(b)	Average ^(c)	Concentration Guide ^(d)
			aCi/m ³	aCi/m ³		aCi/m ³	aCi/m ³	aCi/m ³
Total alpha ^(h)	Onsite	447	2000 ± 560	520 ± 25	930	8700 ± 1600	570 ± 39	
	Perimeter	181	2100 ± 570	530 ± 48	411	6800 ± 1400	600 ± 67	
	Nearby Communities	26	1100 ± 420	590 ± 100	55	1600 ± 540	680 ± 87	
	Distant Communities	49 ⁽ⁱ⁾	1100 ± 410	410 ± 60	103	8300 ± 1500	790 ± 240	
	COES Stations	78	1200 ± 460	490 ± 54	150	4800 ± 990	570 ± 82	

(a) Location groups are identified in Table 5.2.1.

(b) Maximum single sample result ± 2 total propagated analytical uncertainty. Negative concentration values are explained in the section, "Helpful Information."

(c) Average of all samples ± 2 times the standard error of the mean.

(d) From DOE Derived Concentration Guide (see Appendix C).

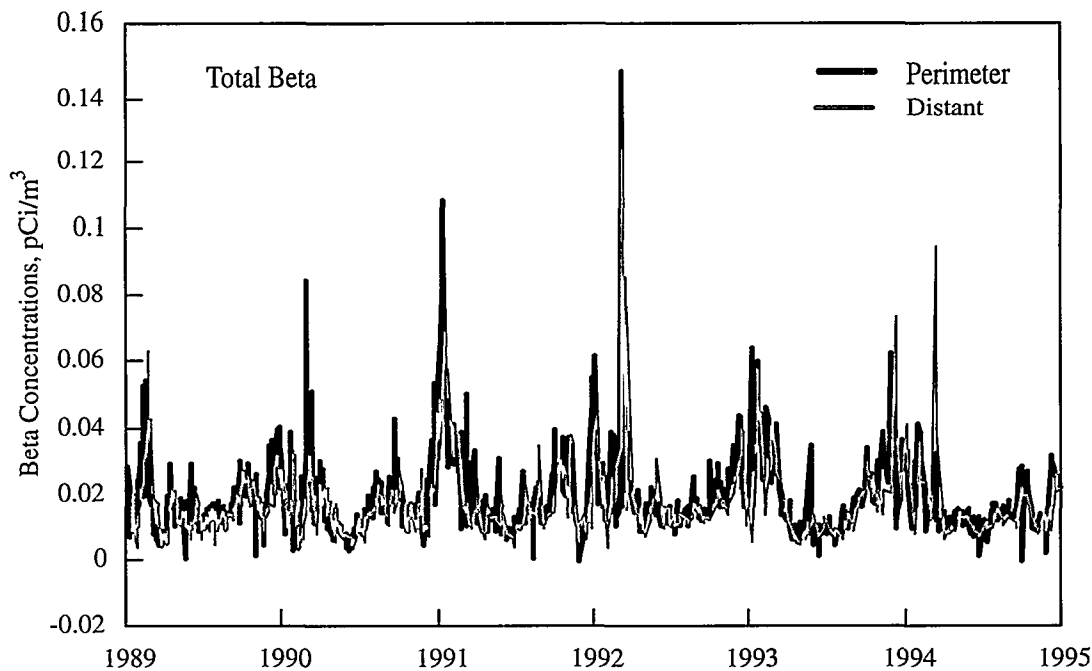
(e) COES = community-operated environmental surveillance (station).

(f) Summation of Uranium-234, -235, and -238.

(g) Americium-241 sampling was initiated in 1993.

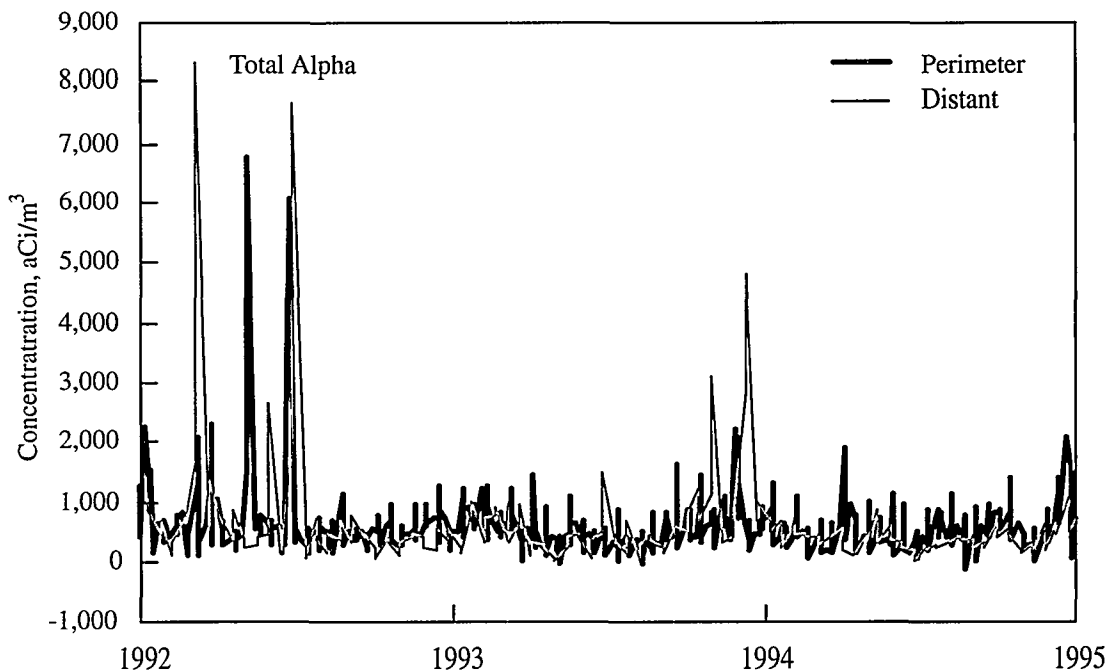
(h) Total alpha values for 1991 and 1992 were not included in Table 5.2.3 because extended storage of these samples before analysis likely resulted in anomalously high concentrations through the ingrowth of alpha-emitting radon and thoron decay products (Sheets and Thompson 1992).

(i) Two results from the distant communities were excluded as anomolous values through the use of a Q-test ($26,000 \pm 3,400$ aCi/m³ at Yakima and $8,000 \pm 1,000$ aCi/m³ at Sunnyside) (Skoog and West 1980).



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Figure 5.2.2 Total Beta Radioactivity in Airborne Particulate Samples, 1989 Through 1994



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Figure 5.2.3 Total Alpha Radioactivity in Airborne Particulate Samples, 1992 Through 1994

station measured consistently elevated concentrations. Even the highest individual concentration reported for 1994 (530 ± 46 pCi/m³ [300 NE location]) was

only 0.5% of the 100,000 pCi/m³ Derived Concentration Guide. For 1994, the annual average tritium concentration measured at the Site perimeter

Table 5.2.3 Airborne Concentrations^(a) of Tritium in the Hanford Environs (pCi/m³), 1989 to 1994

Location Group ^(b)	No. of Samples	Maximum ^(c)	Average (All Data) ^(d)	No. of Samples	Average Excluding Data \geq 100 pCi/m ³ ^(e)
1989					
Onsite	77	4.5 \pm 1.3	1.4 \pm 0.20	77	1.4 \pm 0.20
Perimeter	100	2.9 \pm 1.2	0.90 \pm 0.16	100	0.90 \pm 0.16
Distant Comm.	26	2.4 \pm 1.3	0.81 \pm 0.32	26	0.81 \pm 0.32
1990					
Onsite	48	71 \pm 2.3	3.1 \pm 1.5	48	3.1 \pm 1.5
Perimeter	96	12 \pm 1.3	1.5 \pm 0.21	96	1.5 \pm 0.21
Distant Comm.	24	3.4 \pm 1.4	1.3 \pm 0.22	24	1.3 \pm 0.22
1991^(f)					
Onsite	91	2,900 \pm 250	59 \pm 71	85	2.8 \pm 1.4
Perimeter	68	4,700 \pm 400	140 \pm 200	66	2.1 \pm 1.1
Distant Comm.	29	350 \pm 31	18 \pm 25	27	2.2 \pm 2.2
COES Stations	30	4,900 \pm 420	210 \pm 340	28	1.9 \pm 0.86
1992^(g)					
Onsite	90	770 \pm 6.0	53 \pm 30	78	5.0 \pm 1.8
Perimeter	63	1,600 \pm 9.4	82 \pm 64	54	4.8 \pm 2.2
Distant Comm.	26	380 \pm 5.4	43 \pm 43	23	5.0 \pm 6.0
COES Stations	40	1,600 \pm 8.4	120 \pm 100	31	6.0 \pm 5.6
1993^(h)					
Onsite	91	600 \pm 4.2	12 \pm 14	89	3.4 \pm 2.2
Perimeter	64	9.9 \pm 1.2	0.90 \pm 0.40	64	0.90 \pm 0.40
Distant Comm.	26	3.8 \pm 4.1	0.83 \pm 0.52	26	0.83 \pm 0.51
COES Stations	34	120 \pm 3.6	4.5 \pm 7.2	33	0.95 \pm 0.40
1994^(h)					
Onsite	101	530 \pm 46	7.8 \pm 11	99	1.3 \pm 0.90
Perimeter	65	3.0 \pm 2.8	0.59 \pm 0.17	65	0.59 \pm 0.18
Distant Comm.	26	2.2 \pm 1.5	0.54 \pm 0.29	26	0.54 \pm 0.29
COES Stations	39	21 \pm 2.2	1.2 \pm 1.1	39	1.2 \pm 1.1

(a) 1994 Derived Concentration Guide = 100,000 pCi/m³.

(b) Onsite, Site perimeter, distant communities, and community-operated environmental surveillance stations are identified in Figure 5.2.1 and Table 5.2.1.

(c) Maximum single sample result \pm 2 total propagated analytical uncertainty.

(d) Average of samples \pm 2 times the standard error of the mean.

(e) Average was calculated by excluding results greater than 100 pCi/m³ to produce a more representative mean that was not influenced by highly suspect results.

(f) 1991 results reported in this table include some values that were excluded from the 1991 Hanford Site Environmental Report because of suspected laboratory contamination. These results are still considered highly suspect but have been included to provide a consistent treatment of the monitoring data. The suspect results were presented in the 1991 data summary (Bisping and Woodruff 1992).

(g) These results contain values that are suspect and may be the result of laboratory contamination (Woodruff et al. 1993). The results differ from the 1992 Hanford Site Environmental Report (Woodruff et al. 1993) to provide a consistent treatment of the data for this table.

(h) These results contain some values that are suspect and may be the result of laboratory contamination.

(0.59 ± 0.17 pCi/m³) was similar to the annual average value at the distant locations (0.54 ± 0.29 pCi/m³). The annual average tritium concentration at the Site perimeter in 1994 was 0.0006% of the Derived Concentration Guide.

All strontium-90 results (Table 5.2.2) for air samples for 1994 were below a nominal detection limit of 98 aCi/m³. The concentration at the detectable limit would only be 0.001% of the 9,000,000 aCi/m³ Derived Concentration Guide.

Iodine-129 was sampled downwind of the PUREX Plant (200-East southeast location), at two downwind perimeter locations, and at a distant location (Yakima) in 1994 (Figure 5.2.4). Onsite concentrations in 1994 were elevated compared to those measured at the Site perimeter, and perimeter concentrations were higher than those measured at Yakima (Table 5.2.2). Iodine-129 concentration differences between these locations were statistically significant (two-tailed t-test, 5% significance level) and showed a measurable Hanford source. Onsite and Site perimeter air concentrations decreased in 1989 compared to previous years (Patton and Cooper 1993) in response to reduced PUREX Plant operations and have remained at their respective levels from 1990 to 1994 (Table 5.2.4). Onsite air concentrations of iodine-129 were influenced by minor emissions (0.014 Ci, Table 3.1.1) from the

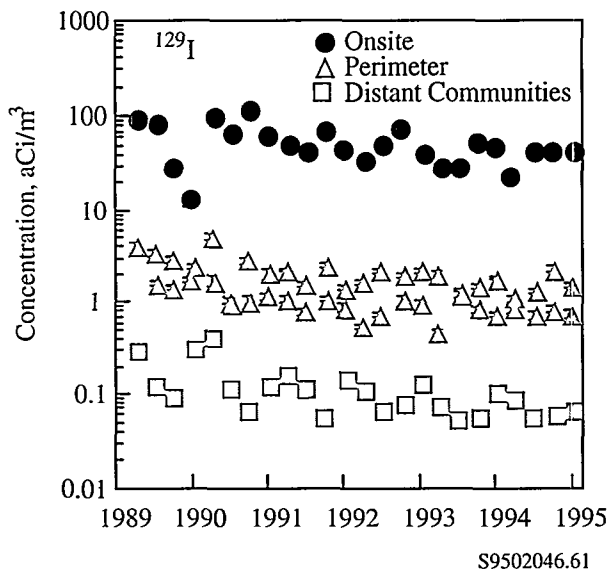


Figure 5.2.4 Concentration (± 2 standard error of the mean) of Iodine-129 in Air, 1989 Through 1994. As a result of figure scale, some uncertainties are concealed by point symbol.

PUREX Plant and possible releases from the storage of dissolved fuel rod solutions in waste storage tanks and cribs. The annual average iodine-129 concentration at the downwind perimeter in 1994

(1.2 ± 0.37 aCi/m³) was 0.000002% of the 70,000,000 aCi/m³ Derived Concentration Guide.

Plutonium-238 was not detected in any air samples for 1994 with a detection limit of 3.5 aCi/m³. This detection limit represents 0.01% of the 30,000 aCi/m³ Derived Concentration Guide for plutonium-238. Plutonium-239,240 was not detected in any onsite or offsite samples for 1994 with a nominal detection limit of 3.3 aCi/m³. This detection limit for plutonium-239,240 represents 0.02% of the 20,000 aCi/m³ Derived Concentration Guide. Figure 5.2.5 shows the average plutonium-239,240 concentrations in air for 1989 to 1994.

Uranium concentrations (uranium-234, -235, and -238) in airborne particulate matter in 1994 were similar at the Site perimeter and at distant communities (Table 5.2.2 and Figure 5.2.6). The 1994 annual average concentration for the Site perimeter was 61 ± 13 aCi/m³, which was 0.05% of the 100,000 aCi/m³ Derived Concentration Guide.

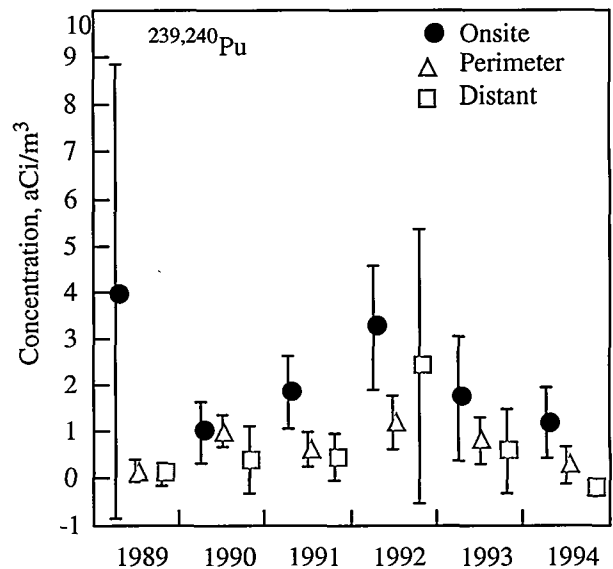


Figure 5.2.5 Annual Average Concentrations (± 2 standard error of the mean) of Plutonium-239, 240 in Air, 1989 Through 1994. As a result of figure scale, some uncertainties are concealed by point symbol.

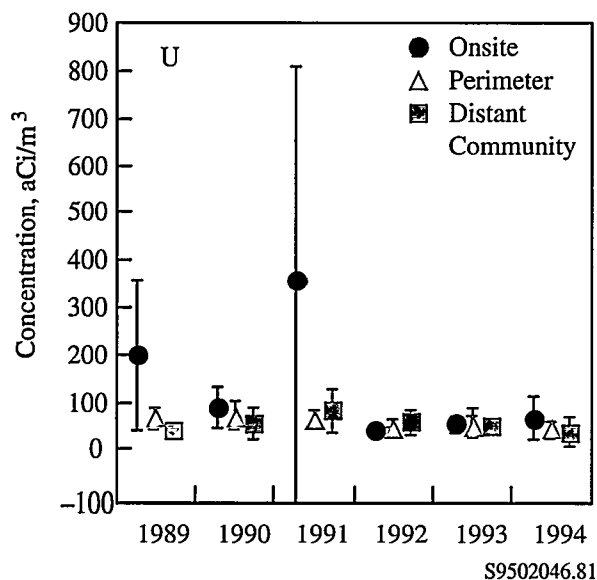


Figure 5.2.6 Annual Average Concentrations (± 2 standard error of the mean) of Uranium in Air, 1989 Through 1994. As a result of figure scale, some uncertainties are concealed by point symbol.

Seven annual air composite samples were analyzed for americium-241 in 1994 and all results (Table 5.2.2) were below a nominal detection limit of 3.2 aCi/m³. This concentration represents 0.02% of the 20,000 aCi/m³ Derived Concentration Guide. Americium-241 was added to the sampling schedule in

1993 to estimate the regional background air concentrations before large-scale remediation work at Hanford.

Cesium-137 and ruthenium-106 associated with airborne particulate matter, and iodine-131 collected on charcoal cartridges, were routinely monitored through gamma-scan analyses. Results were generally below detectable concentrations both on and off the Hanford Site (only 12 of 88 cesium-137 samples, 6 of 100 iodine-131 samples, and 7 of 88 ruthenium-106 samples) had concentrations above the detection limit). The results obtained for 1994 samples are included in Table 5.2.2. Even the maximum individual measurements for these radionuclides were less than 0.02% of their Derived Concentration Guide.

Nonradiological Results

Ten air samples were collected on the Hanford Site and analyzed for volatile organic compounds during 1994. The samples were analyzed for halogenated alkanes and alkenes, benzene, and alkylbenzenes. These compounds are widely used by modern society and are ubiquitous environmental contaminants. The results are given in Table 5.2.4, along with ambient air level goals (AALG) and occupational maximum allowable concentrations. All measured volatile organic compound concentrations were well below occupational maximum allowable

Table 5.2.4 Average Concentrations (ng/L ± 2 standard deviation) of Selected Volatile Organic Compounds in Air on the Hanford Site, 1994

Compound	No. of Samples	300 Area	No. of Samples	200-West Area	No. of Samples	Rattlesnake Springs	MAC ^(a)	AALG ^(b)
dichloromethane	2	0.065 \pm 0.014	2	0.13 \pm 0.0057	0	NA ^(c)	1,800	0.12
1,1,1, - trichloroethane	3	0.64 \pm 0.27	4	0.64 \pm 0.84	2	0.97 \pm 0.34	1,900	36,400
benzene	4	0.55 \pm 0.72	4	0.48 \pm 0.95	2	0.45 \pm 0.97	5	0.096
carbon tetrachloride	3	0.46 \pm 0.37	4	0.60 \pm 0.89	2	0.78 \pm 0.045	12.6	0.053
toluene	4	0.79 \pm 1.0	4	0.43 \pm 0.88	2	0.64 \pm 0.24	375	1,400
m,p-xylene	3	0.77 \pm 0.69	4	0.14 \pm 0.31	2	0.21 \pm 0.065	435	57
o-xylene	3	0.29 \pm 0.33	3	0.059 \pm 0.088	2	0.088 \pm 0.034	435	290

(a) MAC = maximum allowable concentrations; time-weighted average (8-h day, 40-h work week); from 29 CFR 1910, January 1989.

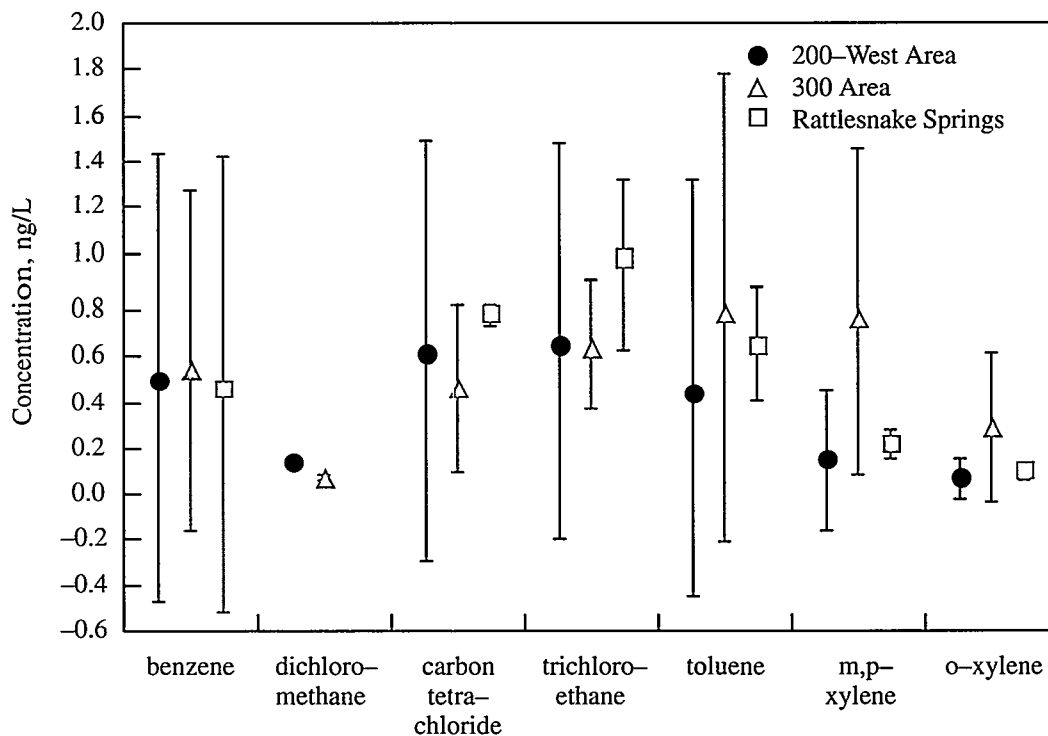
(b) AALG = ambient air level goal (Calabrese and Kenyon 1991).

(c) NA = not available.

concentration values. The AALG are nonregulatory, nonbinding values that were developed by Calabrese and Kenyon (1991) for use as health-based guidelines for risk assessments and are somewhat analogous to the EPA's maximum contaminant level goals for water. The AALG values are used as a comparative tool in this report because no regulatory standards for ambient air concentrations have been established for these compounds.

Compounds that routinely approached or exceeded the AALG values were dichloromethane (methylene chloride), tetrachloromethane (carbon tetrachloride), and benzene. The concentrations of these and other compounds at the 300 Area, 200-West Area, and Rattlesnake Spring locations are shown in Figure 5.2.7. Xylene concentrations at the 300 Area were

slightly elevated relative to those at the background site at Rattlesnake Springs; however, the 300 Area concentrations are influenced by sources both on the Site and in the nearby communities. Benzene concentrations in air were similar for all locations. Carbon tetrachloride was used for past Site operations and is routinely detected in ground-water monitoring wells in the 200-West Area (see Section 5.8). However, there was little difference between average air concentrations of carbon tetrachloride measured on-site and at the background location. Dichloromethane concentrations in air were similar for both the 200-West and 300 Area locations. Overall air concentrations of volatile organic components for 1994 were within the range of values reported from previous studies (Patton et al. 1994).



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Figure 5.2.7 Annual Average Concentrations (± 2 standard error of the mean) of Volatile Organic Compounds in Air on the Hanford Site