8.2 Ambient-Air Monitoring

B. G. Fritz and C. J. Perkins

Atmospheric releases of radioactive materials from Hanford Site facilities and operations to the surrounding region are potential sources of human exposure. At the Hanford Site, radioactive constituents in air are monitored onsite near facilities and operations and at site-wide locations away from facilities, and offsite around the perimeter of the site and in nearby and distant communities. Information about these ambient-air monitoring efforts, including detailed descriptions of air sampling and analysis techniques is provided in DOE's Environmental Monitoring Plan for the Hanford Site (DOE/RL-91-50). Brief summaries of the ambient-air monitoring objectives and the projects that support them can be found in this report in Section 8.0.

Comparing measured radionuclide concentrations from locations on and around the Hanford Site to concentrations measured at upwind sites assumed to be uninfluenced by Hanford Site operations provides an evaluation of the impact of radionuclide air emissions from the Hanford Site on surrounding ambient air. Complete listings of all radiological analytical results summarized in the following sections are reported separately (PNNL-15222, APP. 1; PNNL-15222, APP. 2).

In addition to the radiological monitoring networks, a small non-radiological air-monitoring system is operated onsite. This system measures atmospheric particulate matter (dust) concentrations at a few locations on the Hanford Site. Results are mainly used for scientific studies in an attempt to better understand windblown dust on and around the Hanford Site.

8.2.1 Ambient-Air Monitoring Near Facilities and Operations

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During 2004, a network of continuously operating samplers at 85 locations (Table 8.2.1) (sampling locations illustrated in PNNL-15222, APP. 2) was used to monitor radioactive materials in air near Hanford Site facilities and operations. Air samplers were located primarily at or within approximately 500 meters (1,500 feet) of sites and/or facilities having the potential for, or a history of, environmental releases and were predominantly located in the prevailing downwind direction. Samples were collected according to a schedule established before the 2004 monitoring year. Airborne particles were sampled at each sampling location by drawing air through a glass-fiber filter. The filters were collected biweekly, field surveyed for gross radioactivity, held for at least 7 days, and then analyzed for gross alpha and beta activity. The 7-day holding period was necessary to allow for the decay of naturally occurring, short-lived radionuclides that would otherwise obscure detection of longer-lived radionuclides associated with emissions from nuclear facilities. The gross radioactivity measurements were used to indicate changes in trends in the near-facility environment.

For most specific radionuclide analyses, the amount of radioactive material collected on a single filter during a 2-week period was too small to be measured accurately. To increase the accuracy of the analysis, the samples were combined into either quarterly or semiannual composite

Table 8.2.1. Monitoring Locations and Analyses for Ambient-Air Monitoring Samples Collected Near Hanford Site Facilities and Operations, 2004

Site	Number of Samplers	EDP Code[(a)]	Analyses: Biweekly	Analyses: Composite[(b)]
100-B/C remedial action project	5	N464, N465, N466, N496, N497	Gross alpha, gross beta	Gamma, Sr, Pu, U
105-D interim safe storage project	1	N523	Gross alpha, gross beta	Gamma, Sr, Pu, U
105-DR interim safe storage project	2	N492, N515	Gross alpha, gross beta	Gamma, Sr, Pu, U
105-F interim safe storage project	2	N494, N495	Gross alpha, gross beta	Gamma, Sr, Pu, U
105-H interim safe storage project	2	N524, N525	Gross alpha, gross beta	Gamma, Sr, Pu, U
100-K spent nuclear fuels	8	N401, N402, N403, N404, N476, N477, N478, N479	Gross alpha, gross beta	Gamma, Sr, Pu, U, ^{241}Pu, ^{241}Am
100-KR-1 remedial action project	3	N528, N529, N530	Gross alpha, gross beta	Gamma, Sr, Pu, U
100-NR-1 remedial action and 100-N surveillance, maintenance/transition projects	4	N102, N103, N106, N526	Gross alpha, gross beta	Gamma, Sr, Pu, U
200-East Area	17	N019, N158, N498, N499, N957, N967, N968, N969, N970, N972, N973, N976, N977, N978, N984, N985, N999	Gross alpha, gross beta	Gamma, Sr, Pu, U
Canister Storage Building, 200-East Area	2	N480, N481	Gross alpha, gross beta	Gamma, Sr, Pu, U, ^{241}Pu, ^{241}Am
224-B demolition project, 200-East Area	3	N541, N542, N543	Gross alpha, gross beta	Gamma, Sr, Pu, U
Integrated Disposal Facility, 200-East Area	1	N532	Gross alpha, gross beta	Gamma, Sr, Pu, U
200-West Area	21	N155, N161, N165, N168, N200, N304, N433, N441, N442, N449, N456, N457, N956, N963, N964, N965, N966, N974, N975, N987, N994	Gross alpha, gross beta	Gamma, Sr, Pu, U
U Ancillary Decontamination and Demolition, 200-West Area	2	N550, N551	Gross alpha, gross beta	Gamma, Sr, Pu, U
300-FF-2 remedial action project, 300 Area	8	N130, N527, N537, N538, N539, N540, N548, N549,	Gross alpha, gross beta	Gamma, Sr, Pu, U
Environmental Restoration Disposal Facility	3	N482, N517, N518	Gross alpha, gross beta	Gamma, Sr, Pu, U
600 Area	1	N981	Gross alpha, gross beta	Gamma, Sr, Pu, U

(a) EDP Code = Sampler location code. See PNNL-15222, APP. 2.
(b) Gamma spectroscopy, strontium-90, isotopic plutonium (^{238}Pu, $^{239/240}$Pu), and isotopic uranium (^{234}U, ^{235}U, and ^{238}U).

samples for each location. Composite samples were routinely analyzed for gamma-emitting isotopes, strontium-90, plutonium-238, plutonium-239/240, uranium-234, uranium-235, and uranium-238, and at locations associated with processing spent nuclear fuel, americium-241, and plutonium-241 (Table 8.2.1). Naturally occurring radionuclides beryllium-7 and potassium-40 were routinely identified.

Ambient-Air Monitoring Results for Locations Near Facilities and Operations

Figure 8.2.1 shows the annual average air concentrations of selected radionuclides in the 100 and 200/600 Areas compared to the DOE derived concentration guides and, when available, air concentrations measured in distant communities. The DOE derived concentration guides (DOE Order 5400.5; Appendix D, Table D.5) are dose-based reference values that are used as indexes of performance. The 2004 data indicate a large degree of variability. Air samples collected from locations at or directly adjacent to Hanford Site facilities had higher radionuclide concentrations than did those samples collected farther away. In general, analytical results for most radionuclides were at or near Hanford Site background levels, which are much less than DOE derived concentration guides but greater than those measured off the site. The data also show that concentrations of certain radionuclides were higher and widely variable within different onsite operational areas. Table 8.2.2 shows the annual average and maximum concentrations of radionuclides in air samples collected near facilities and operations during 2004. A complete listing of the 2004 near-facility ambient-air monitoring results can be found in PNNL-15222, APP. 2. Concentrations of radionuclides in air in the 300 and 400 Areas, near some onsite remediation projects, and offsite at distant locations were collected by Pacific Northwest National Laboratory personnel. Results for Pacific Northwest National Laboratory air samples are summarized in Section 8.2.2.

At the remedial action project site in the 100-B/C Area, ambient air monitoring was conducted at five locations in 2004. The radionuclides uranium-234, uranium-235, and uranium-238 were consistently detected and plutonium-239/240 was detected in 25% of the composited samples.

During 2004, air monitoring continued at seven locations associated with the interim safe storage of the reactor buildings in the 100-D/DR, 100-F, and 100-H Areas. The quarterly analytical results from these air samples showed radionuclide concentrations and frequency of detection consistent with results observed over the past 5 years. Uranium-234 and uranium-238 were consistently detected (in 82% and 71% of the samples, respectively). Plutonium-239/240 was detected in approximately 18% of the quarterly composite samples.

The airborne contaminant levels in the 100-K Area were similar to those measured over the previous years. Ambient-air monitoring was conducted at eight locations during 2004 (four stations each at the 100-K East and 100-K West Areas). Uranium-234 and uranium-238 were detected in approximately 90% of the composite samples obtained during 2004. Americium-241 and plutonium-241 were detected in about half of the composite samples, while uranium-235 and plutonium-239/240 were detected in approximately 25% of the samples.

Air sampling continued in 2004 at three locations at the 100-KR-1 remedial action site. Uranium-234 and uranium-238 were detected in approximately 90% of the composite samples obtained during 2004. Uranium-235 and plutonium-239/240 were detected in approximately 25% and 38% of the samples, respectively.

Analytical results from four ambient-air sampling locations at the 100-NR-1 remedial action site and 100-N Area surveillance and maintenance and transition site in 2004 were similar to those measured in previous years. Uranium-234 and uranium-238 were detected in all the composite samples. Cesium-137 and plutonium-239/240 were detected in 50% of the samples, while cobalt-60 and uranium-235 were detected in 25% of the samples.

Air sampling was conducted at 23 locations in the 200-East Area during 2004. Four of these locations were established in September 2004: three were project-specific air sampling locations at the 224-B Demolition Project site, and one was a pre-operational monitoring location at the Integrated Disposal Facility. During 2004, radionuclide levels measured in the 200-East Area ambient air composite samples were similar to those measured over the previous years. Uranium-234 and uranium-238 were detected in more than 90% of the samples and uranium-235 was detected in less than 20% of the samples.

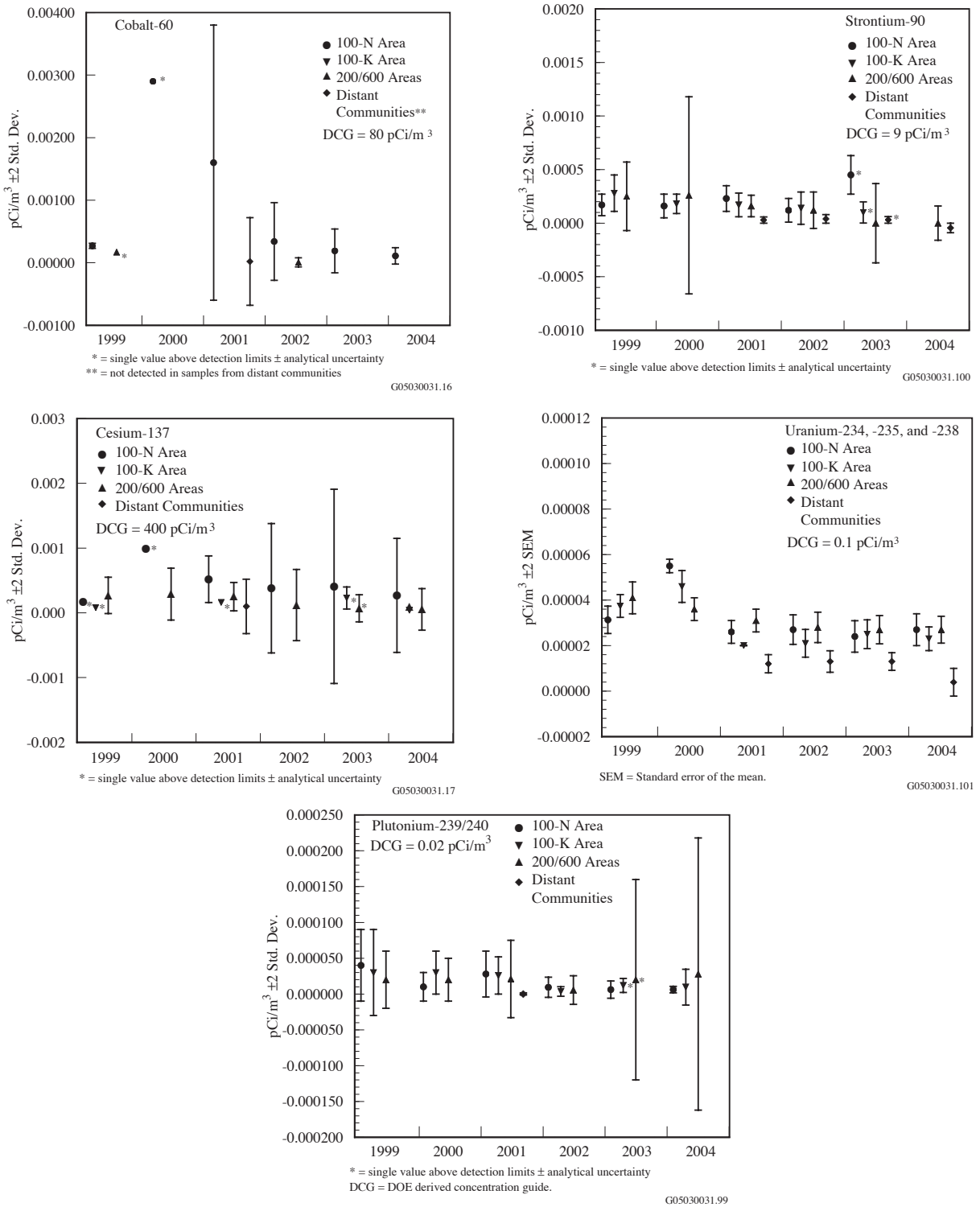

Figure 8.2.1. Average Concentrations of Selected Radionuclides in Ambient-Air Samples Collected on the Hanford Site Near Facilities and Operations Compared to Those Collected in Distant Communities (PNNL-14295), 1999 through 2004. Radionuclide concentrations below analytical detection limits are not shown. As a result of figure scale, some uncertainties (error bars) are concealed by the point symbol.

Table 8.2.2. Annual Average and Maximum Concentrations (aCi/m^3)[a] of Selected Radionuclides in Ambient-Air Samples Collected Near Facilities and Operations on the Hanford Site, 2004

Cobalt-60

Site	Average[b]	Maximum[c]	EDP Code[d]
100-B/C RA	15 ± 83	73 ± 81	N497
100 Area ISS	70 ± 290	560 ± 1,300	N515
100-K SNF	17 ± 94	120 ± 85	N478
100-K RA	0.33 ± 110	49 ± 85	N528
100-N	110 ± 130	200 ± 110	N102
200-East	-7.2 ± 85	92 ± 85	N970
200-West	18 ± 110	150 ± 130	N200
300-FF-2 (300 Area)	-150 ± 410	36 ± 73	N130
ERDF	5.4 ± 120	69 ± 120	N517
Distant community[e]	100 ± 600	670 ± 610	
DCG		80,000,000	

Strontium-90

Site	Average[b]	Maximum[c]	EDP Code[d]
100-B/C RA	-140 ± 320	-83 ± 86	N466
100 Area ISS	-160 ± 400	140 ± 160	N492
100-K SNF	-49 ± 170	70 ± 74	N479
100-K RA	-72 ± 150	35 ± 92	N529
100-N	-26 ± 76	28 ± 87	N102
200-East	-22 ± 180	360 ± 160	N984
200-West	-55 ± 140	98 ± 100	N981
300-FF-2 (300 Area)	-28 ± 81	0.14 ± 1.4	N130
ERDF	-27 ± 150	120 ± 130	N517
Distant community[e]	-45 ± 180	100 ± 47	
DCG		9,000,000	

Cesium-137

Site	Average[b]	Maximum[c]	EDP Code[d]
100-B/C RA	21 ± 110	150 ± 200	N464
100 Area ISS	36 ± 370	510 ± 300	N524
100-K SNF	41 ± 95	140 ± 130	N403
100-K RA	20 ± 100	74 ± 78	N529
100-N	270 ± 880	1,300 ± 480	N526
200-East	26 ± 87	140 ± 97	N984
200-West	74 ± 410	1,300 ± 510	N155
300-FF-2 (300 Area)	110 ± 340	460 ± 780	N540
ERDF	33 ± 41	56 ± 74	N517
Distant community[e]	-88 ± 510	430 ± 690	
DCG		400,000,000	

Uranium-234

Site	Average[b]	Maximum[c]	EDP Code[d]
100-B/C RA	14 ± 18	36 ± 21	N464
100 Area ISS	23 ± 27	63 ± 75	N515
100-K SNF	11 ± 9.5	22 ± 11	N401
100-K RA	12 ± 5.3	15 ± 8.9	N529
100-N	14 ± 7.0	18 ± 10	N102
200-East	14 ± 16	40 ± 22	N543
200-West	12 ± 9.0	28 ± 14	N161
300-FF-2 (300 Area)	89 ± 160	190 ± 97	N538
ERDF	21 ± 26	48 ± 22	N517
Distant community[e]	-5.8 ± 42	26 ± 10	
DCG		90,000	

Uranium-238

Site	Average[b]	Maximum[c]	EDP Code[d]
100-B/C RA	11 ± 7.9	17 ± 16	N465
100 Area ISS	20 ± 34	78 ± 73	N515
100-K SNF	9.1 ± 6.1	17 ± 9.7	N403
100-K RA	9.7 ± 6.3	15 ± 8.7	N529
100-N	11 ± 7.7	15 ± 9.5	N102
200-East	12 ± 13	33 ± 18	N541
200-West	11 ± 10	24 ± 19	N987
300-FF-2 (300 Area)	67 ± 110	130 ± 79	N537
ERDF	21 ± 26	49 ± 22	N517
Distant community[e]	20 ± 14	28 ± 11	
DCG		100,000	

Plutonium-239/240

Site	Average[b]	Maximum[c]	EDP Code[d]
100-B/C RA	4.5 ± 14	19 ± 16	N465
100 Area ISS	7.3 ± 32	67 ± 63	N515
100-K SNF	9.7 ± 22	41 ± 24	N402
100-K RA	3.4 ± 5.3	6.7 ± 5.4	N526
100-N	6.2 ± 4.6	9.7 ± 6.3	N526
200-East	2.0 ± 6.8	13 ± 14	N481
200-West	51 ± 260	540 ± 210	N165
300-FF-2 (300 Area)	2.8 ± 15	15 ± 9.0	N130
ERDF	22 ± 89	130 ± 52	N963
Distant community[e]	-0.030 ± 1.3	1.5 ± 4.3	
DCG		20,000	

Plutonium-241

Site	Average[b]	Maximum[c]	EDP Code[d]
100-K SNF	210 ± 2,400	1,700 ± 830	N478
200-East	50 ± 3,200	1,700 ± 870	N480
Distant community[e]		Not reported	
DCG		1,000,000	

Americium-241

Site	Average[b]	Maximum[c]	EDP Code[d]
100-K SNF	10 ± 19	36 ± 19	N402
200-East	5.1 ± 2.2	6.4 ± 5.0	N481
Distant community[e]		Not reported	
DCG		20,000	

(a) To convert to international metric system units, multiply aCi/m^3 by 0.000000037 to obtain Bq/m^3.
(b) ±2 times the standard deviation.
(c) ± total analytical uncertainty.
(d) EDP Code = Sampler location code. See PNNL-15222, APP. 2.
(e) See Section 8.2.2.
DCG = DOE derived concentration guide.
ERDF = Environmental Restoration Disposal Facility.
ISS = Interim safe storage projects at 105-DR/F/D/H.
RA = Remedial action project.
SNF = Spent nuclear fuel.

Air sampling was conducted at 23 locations in the 200-West Area during 2004. Generally, radionuclide levels measured in the 200-West Area were similar to results for previous years. Uranium-234 and uranium-238 were detected in approximately 85% of the samples. Plutonium-239/240 was detected in approximately 50% of the samples and uranium-235 in approximately 30%. Two locations were established in 2004 at the U Ancillary Decontamination and Demolition Project site. Three previously established air sampling locations provided ambient air monitoring data for the 233-S Demolition Project, which concluded in June 2004. The highest plutonium-239/240 and cesium-137 concentrations observed in near-facility air samples during 2004 were from two of the three sampling stations in the vicinity of the 233-S Demolition Project site and were measured in composite samples collected during the first half of the year. There may be a correlation between the elevated plutonium-239/240 results and the elevated total alpha results observed at all three air sampling locations during the period March 29, 2004 through April 12, 2004. The plutonium-239/240 results were less than 3% of the DOE derived concentration guide and the cesium-137 results were approximately 0.0003% of the DOE derived concentration guide (Appendix D, Table D.5).

The air sampling network at the Environmental Restoration Disposal Facility (200-West Area) used two established samplers for upwind monitoring (one near-facility sampler, N-963, and one Pacific Northwest National Laboratory sampler, station #13 at the 200 W SE location) (Section 8.2.2) and three air samplers at the facility that provided downwind coverage. The 2004 analytical results were comparable to those obtained in 2003. Uranium-234 and uranium-238 were detected in over 90% of the near-facility composite samples and plutonium-239/240 was detected in approximately 38%.

Remediation work in the 300-FF-2 Operable Unit (located near the 300 Area) during 2004 was conducted at several locations at different times and as a result, eight ambient-air monitoring stations were intermittently employed during the year. Uranium-234 and uranium-238 were detected in approximately 95% of the samples and uranium-235 in approximately 20% of the samples. The highest uranium-234 and uranium-238 concentrations observed in near-facility air samples during 2004 were from two sampling stations at the 618-7 remediation site within the 300-FF-2 Operable Unit and were measured in composite samples collected during August and September. The uranium-234 and uranium-238 results were, respectively, 0.2% and 0.1% of the DOE derived concentration guide (Appendix D, Table D.5) and may have been associated with the remediation activities.

The 300 Area cleanup and decommissioning activities discussed above are described in more detail in Section 6.1.4.

8.2.2 Site-Wide and Offsite Ambient-Air Monitoring

B. G. Fritz

During 2004, airborne radionuclide samples were collected by 44 continuously operating samplers. The sampling stations were grouped into four location groups: site-wide (onsite) (23 stations), perimeter (11 stations), community (8 stations), and distant (2 stations) (Figure 8.2.2 and Table 8.2.3). Four of the stations were community-operated environmental surveillance stations (Section 8.17) that were managed and operated by local schoolteachers as part of an ongoing DOE-sponsored program to promote public awareness of Hanford Site environmental monitoring programs. Air samplers on the Hanford Site were located primarily around major operational areas to maximize the ability to detect radiological contaminants resulting from site operations. Perimeter samplers were located around the site boundary, with emphasis on the prevailing downwind directions to the south and east of the site. Samplers located in Basin City, Benton City, Kennewick, Mattawa, Othello, Pasco, and Richland, Washington, provided data for the nearest population centers. Samplers in Toppenish and Yakima, Washington, provided background data for communities essentially unaffected by Hanford Site operations.

8.2.2.1 Collection of Site-Wide and Offsite Ambient-Air Samples and Analytes Tested

Samples were collected according to a schedule established before the monitoring year (*Hanford Site Environmental Surveillance Master Sampling Schedule*, PNNL-14184) and analyzed for up to eight analytes (Table 8.2.3). Airborne

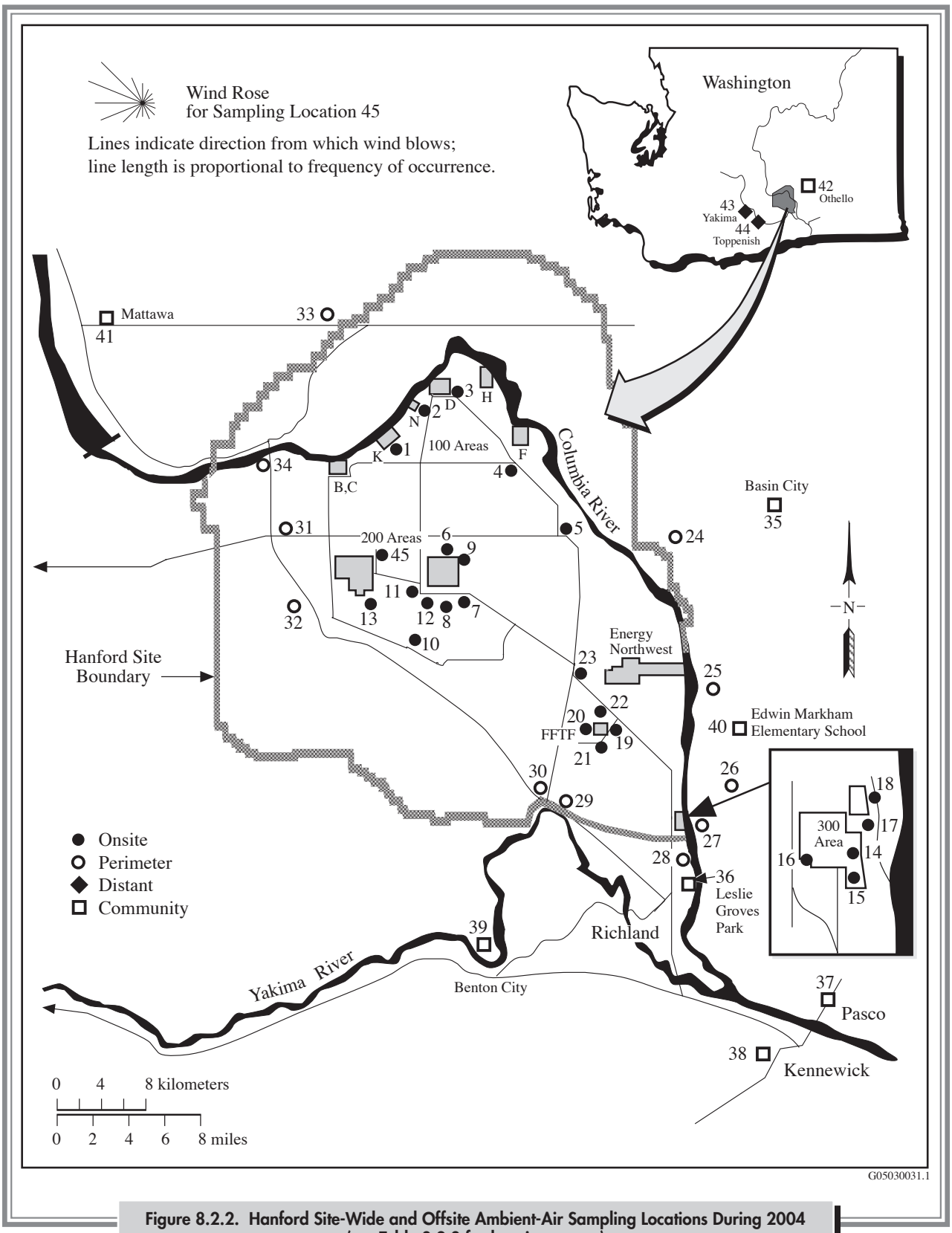

Figure 8.2.2. Hanford Site-Wide and Offsite Ambient-Air Sampling Locations During 2004 (see Table 8.2.3 for location names)

Table 8.2.3. Site-Wide and Offsite Ambient-Air Sampling Locations, Sample Composite Groups, and Analytes, 2004

Map[a] Location	Sampling Location	Analytes[b]	Composite Group	Analytes[c]
Site-Wide (Onsite)				
1	100 K Area	Alpha, Beta, ^{3}H	100 Areas	Gamma, Sr, Pu
2	100 N-1325 Crib	Alpha, Beta, ^{3}H		
3	100 D Area	Alpha, Beta		
4	100 F Met Tower	Alpha, Beta	Hanford Townsite	Gamma, Sr, Pu
5	Hanford Townsite	Alpha, Beta		
6	N of 200 E	Beta	N of 200 E	Gamma
7	200 ESE	Alpha, Beta, ^{3}H, ^{129}I	200 E Area	Gamma, Sr, Pu, U
8	S of 200 E	Alpha, Beta		
9	B Pond	Alpha, Beta	B Pond	Gamma, Sr, Pu, U
10	Army Loop Camp	Alpha, Beta	200 W South East	Gamma, Sr, Pu, U
11	200 Tel. Exchange	Alpha, Beta, ^{3}H		
12	SW of B/C Crib	Alpha, Beta		
13	200 W SE	Alpha, Beta	200 West	Gamma, Sr, Pu, U
14	300 Water Intake	Alpha, Beta, ^{3}H	300 Area	Gamma, Sr, Pu, U
15	300 South Gate	Alpha, Beta, ^{3}H		
16	300 South West	Alpha, Beta, ^{3}H		
17	300 Trench	Alpha, Beta, ^{3}H U, Gamma	300 NE	Sr, Pu
18	300 NE	Alpha, Beta, ^{3}H U, Gamma		
19	400 E	Alpha, Beta, ^{3}H	400 Area	Gamma, Sr, Pu
20	400 W	Alpha, Beta		
21	400 S	Alpha, Beta		
22	400 N	Alpha, Beta		
23	Wye Barricade	Alpha, Beta	Wye Barricade	Gamma, Sr, Pu, U
Perimeter				
24	Ringold Met Tower	Alpha, Beta, ^{3}H, ^{129}I	Ringold Met Tower	Gamma, Sr, Pu
25	W End of Fir Road	Alpha, Beta	W End of Fir Road	Gamma, Sr, Pu, U
26	Dogwood Met Tower	Alpha, Beta, ^{3}H	Dogwood Met Tower	Gamma, Sr, Pu, U
27	Byers Landing	Alpha, Beta, ^{3}H, ^{129}I	Byers Landing	Gamma, Sr, Pu, U
28	Battelle Complex	Alpha, Beta, ^{3}H	Battelle Complex	Gamma
29	Horn Rapids Substation	Alpha, Beta	Prosser Barricade	Gamma, Sr, Pu, U
30	Prosser Barricade	Alpha, Beta, ^{3}H		
31	Yakima Barricade	Alpha, Beta	Yakima Barricade	Gamma, Sr, Pu
32	Rattlesnake Springs	Alpha, Beta		
33	Wahluke Slope	Alpha, Beta, ^{3}H	Wahluke Slope	Gamma, Sr, Pu
34	S End Vernita Bridge	Alpha, Beta		

Table 8.2.3. (contd)

Map[a] Location	Sampling Location	Analytes[b]	Composite Group	Analytes[c]
Nearby Communities				
35	Basin City School[d]	Alpha, Beta, ^{3}H	Basin City School	Gamma, Sr, Pu, U
36	Leslie Groves-Rchlnd[d]	Alpha, Beta, ^{3}H	Leslie Groves-Rchlnd	Gamma, Sr, Pu, U
37	Pasco	Beta	Tri-Cities	Gamma, Sr, Pu
38	Kennewick	Alpha, Beta		
39	Benton City	Beta	Benton City	Gamma
40	Edwin Markham School[d]	Alpha, Beta, ^{3}H	Edwin Markham School	Gamma, Sr, Pu, U
41	Mattawa	Beta	Mattawa	Gamma
42	Othello	Beta	Othello	Gamma
Distant Communities				
43	Yakima	Alpha, Beta, ^{3}H, ^{129}I	Yakima	Gamma, Sr, Pu, U
44	Toppenish[d]	Alpha, Beta, ^{3}H	Toppenish	Gamma, Sr, Pu, U
Non-Radiological Monitoring				
45	Hanford Meteorology Station	PM_{10}, $PM_{2.5}$[e]		

(a) See Figure 8.2.2.
(b) Alpha (gross) and beta (gross) samples are collected and analyzed every 2 weeks, ^{3}H samples are collected and analyzed every 4 weeks, and ^{129}I samples are collected every 4 weeks, combined into a quarterly composite sample and analyzed for each location.
(c) Gamma spectroscopy, strontium-90, isotopic plutonium (^{238}Pu, $^{239/240}Pu$), and isotopic uranium (^{234}U, ^{235}U, ^{238}U) analyses are performed on quarterly composite samples.
(d) A community-operated environmental surveillance station.
(e) See Section 8.2.2.3.

particle samples were collected biweekly at each location by continuously drawing air through a high efficiency glass-fiber filter. The samples were transported to an analytical laboratory and stored for at least 72 hours. 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 Site emissions. The filters were then analyzed for gross beta radiation. Selected filters were also analyzed for gross alpha radiation. Historically, for most radionuclides, the amount of radioactive material collected on a filter during a 2-week period has been too small for accurate analysis of radionuclides of concern. In order to increase the sensitivity and accuracy of the analysis, biweekly samples were combined into quarterly composite samples. The compositing procedure results in a 12-week-average concentration. The quarterly composite samples were analyzed for gamma-emitting radionuclides (Appendix F). Most composite samples were also analyzed for strontium-90, plutonium-238, plutonium-239/240, uranium-234, uranium-235, and uranium-238.

Samples were collected for iodine-129 analysis at four locations by drawing air through a cartridge containing an adsorbent material. Samples were collected monthly and combined to form quarterly composite samples for each location.

Atmospheric water vapor was collected for tritium analysis at 21 locations by continuously drawing air through multi-column samplers containing adsorbent silica gel. The water-vapor samplers were exchanged every 4 weeks to prevent loss of the sample as a result of breakthrough (i.e., over saturation). The collection efficiency of the silica gel

adsorbent is discussed in Patton et al. (1997). The collected water was distilled from the silica gel and analyzed for its tritium content.

8.2.2.2 Ambient-Air Monitoring Results for Site-Wide and Offsite Samples

All sample results showed very low radiological concentrations in air during 2004. All concentrations were below the DOE derived concentration guides (Appendix D, Table D.5) for each radionuclide analyzed (Table 8.2.4). The DOE derived concentration guide values are based on a 100 mrem (1 mSv) per year dose. A more conservative dose standard is the EPA *Clean Air Act* standard of 10 mrem (100 μSv) per year from airborne radiological material. All radionuclide concentrations in air samples collected in 2004 were less than one-tenth of the DOE derived concentration guide values, which correlates to concentrations that would result in a 10 mrem (100 μSv) per year dose.

Gross alpha concentrations were essentially the same at all site-wide and offsite locations during 2004 (Table 8.2.4). Samples collected around the Hanford Site perimeter had slightly lower average gross alpha concentrations than samples collected at site-wide, distant, and community locations, but the differences were not statistically significant (two-sample means t-test, 95% confidence level). The average site-wide and distant alpha concentrations were the same in 2004 (Figure 8.2.3). The highest gross alpha concentration for 2004 was observed at a site-wide location near the 400 Area (3,900 aCi/m^3 [140 μBq/m^3]). The average gross alpha concentrations observed in individual location groups during 2004 were slightly lower than the 5-year average concentrations observed in the groups from 1999 through 2003 (Table 8.2.4).

Gross beta concentrations in air peaked during the winter months in 2004 (Figure 8.2.4), repeating a pattern of natural radioactivity fluctuations (Eisenbud 1987). The annual average gross beta concentration at site-wide locations during 2004 was slightly higher than at the distant locations. The difference was small and not statistically significant (two-sample means t-test, 95% confidence level). The average gross beta concentrations reported for 2004 were similar to concentrations measured from 1999 through 2003 (Table 8.2.4). Concentrations appeared to be inversely proportional to the average wind speed over the sampling period (Figures 8.2.4 and 8.2.5). This is similar to other studies that have seen a negative correlation between wind speed and the concentrations of radon and radon decay products (Duenas et al. 2003; Ho and Measday 2005; Marcazzan et al. 2003; Winkler et al. 2001). It is likely that a majority of the gross beta activity observed in site-wide and offsite air samples is lead-210, a radon decay product, explaining the similarity between gross beta concentrations at all sampling locations on and off of the Hanford Site.

Tritium concentrations measured at all locations during 2004 were similar to average values reported for 1999 through 2003 (Table 8.2.4). The annual average 300 Area, perimeter, and community concentrations were higher than the average distant concentration, although the differences were not statistically significant (two-sample means t-test, 95% confidence level). The sample with the highest tritium concentration measured during 2004 (66 pCi/m^3 [2.4 Bq/m^3]) was collected at the Battelle Complex in Richland (location 28 on Figure 8.2.2) during May. This concentration was 0.55% of the DOE derived concentration guide (Appendix D, Table D.5).

Iodine-129 analyses were performed on samples collected at a site-wide location downwind of the Plutonium-Uranium Extraction (PUREX) Plant, at two downwind perimeter locations, and at a distant location (Yakima) in 2004 (Table 8.2.3). Concentrations measured site-wide during 2004 were elevated compared to those measured at the site perimeter, and perimeter levels were higher than those measured at the distant location in Yakima (Figure 8.2.6). Concentration differences between these locations were statistically significant and indicated a Hanford Site source. Site-wide and perimeter concentrations observed in 2004 were consistent with the levels observed from 1999 through 2003 (Table 8.2.4). Site-wide air concentrations of iodine-129 were influenced by minor emissions (Table 8.1.1) from the Plutonium-Uranium Extraction (PUREX) Plant and possible releases from waste storage tanks and cribs. The annual average iodine-129 concentration observed at the downwind perimeter in 2004 (0.90 aCi/m^3 [0.033 μBq/m^3]) was 0.00000013% of the DOE derived concentration guide (70 million aCi/m^3 [2.6 Bq/m^3]).

Table 8.2.4. Airborne Radionuclide Concentrations in the Environs of the Hanford Site, 2004 Compared to Previous Years

Radionuclide (approximate detection limit)	Location Group[a]	2004 No. of Samples	2004 No. of Detections[b]	2004 Maximum[c]	2004 Average[d]	1999-2003 No. of Samples	1999-2003 No. of Detections[b]	1999-2003 Maximum[c]	1999-2003 Average[d]	Derived Concentration Guide[e]
				pCi/m^3[f]	pCi/m^3[f]			pCi/m^3[f]	pCi/m^3[f]	pCi/m^3[f]
Tritium (1.0 pCi/m^3)	300 Area	78	66	22 ± 6.6	3.8 ± 5.4	373	365	23 ± 2.1	5.4 ± 7.5	100,000
	Site-wide	67	51	15 ± 2.4	2.8 ± 5.2	323	258	16 ± 2.4	3.1 ± 5.1	
	Perimeter	82	64	66 ± 29	5.2 ± 17	363	282	74 ± 10	4.4 ± 12	
	Nearby communities	42	32	61 ± 8.5	6.8 ± 21	190	161	47 ± 6.8	4.5 ± 12	
	Distant communities	26	15	24 ± 3.8	3.5 ± 10	125	73	11 ± 2.2	2.2 ± 4.3	
Gross beta (0.001 pCi/m^3)	Site-wide	601	601	0.065 ± 0.012	0.016 ± 0.019	3,045	3,036	0.084 ± 0.014	0.015 ± 0.018	No standard
	Perimeter	289	288	0.056 ± 0.0098	0.017 ± 0.021	1,382	1,381	0.074 ± 0.012	0.015 ± 0.017	
	Nearby communities	209	208	0.055 ± 0.0097	0.016 ± 0.020	1,055	1,054	0.056 ± 0.0094	0.015 ± 0.017	
	Distant communities	54	54	0.046 ± 0.0076	0.015 ± 0.017	279	277	0.059 ± 0.010	0.014 ± 0.017	
				aCi/m^3[g]	aCi/m^3[g]			aCi/m^3[g]	aCi/m^3[g]	aCi/m^3[g]
Gross alpha (350 aCi/m^3)	Site-wide	601	375	3,900 ± 1,200	550 ± 900	2,992	2,067	3,600 ± 1,500	610 ± 880	No standard
	Perimeter	289	189	1,700 ± 880	510 ± 610	1,361	982	5,100 ± 1,300	610 ± 900	
	Nearby communities	107	75	2,400 ± 850	560 ± 680	564	422	6,300 ± 1,700	680 ± 1,100	
	Distant communities	54	38	1,300 ± 630	550 ± 640	279	181	5,500 ± 1,900	590 ± 1,100	
Strontium-90 (70 aCi/m^3)	Site-wide	40	0	14 ± 37	-35 ± 80	208	56	1,300 ± 280	34 ± 210	9,000,000
	Perimeter	28	0	33 ± 35	-47 ± 90	145	19	390 ± 79	17 ± 97	
	Nearby communities	16	0	44 ± 47	-50 ± 110	84	11	220 ± 190	25 ± 100	
	Distant communities	8	0	30 ± 51	-76 ± 130	40	3	300 ± 100	13 ± 130	
Iodine-129 (0.01 aCi/m^3)	Site-wide	4	4	24 ± 1.9	19 ± 8.7	21	21	27 ± 1.3	19 ± 9.3	70,000,000
	Perimeter	8	8	0.90 ± 0.066	0.52 ± 0.47	38	38	1.4 ± 0.084	0.55 ± 0.68	
	Distant communities	4	4	0.07 ± 0.0076	0.043 ± 0.048	20	20	0.22 ± 0.015	0.051 ± 0.090	
Plutonium-238 (2 aCi/m^3)	Site-wide	40	4	13 ± 3.9	0.50 ± 4.5	208	10	5.3 ± 1.7	0.013 ± 1.6	30,000
	Perimeter	28	0	1.7 ± 2.4	0.12 ± 1.3	145	1	1.9 ± 1.4	-0.17 ± 1.1	
	Nearby communities	16	0	1.3 ± 2.3	0.088 ± 1.3	84	1	3.7 ± 3.6	-0.17 ± 1.6	
	Distant communities	8	0	0.98 ± 1.4	0.20 ± 0.93	40	0	0.37 ± 1.8	-0.49 ± 1.0	
Plutonium-239/240 (2 aCi/m^3)	Site-wide	40	7	17 ± 4.8	1.5 ± 8.0	208	52	36 ± 6.4	1.4 ± 7.0	20,000
	Perimeter	28	1	2.5 ± 2.1	0.052 ± 1.8	145	7	5.2 ± 2.5	0.36 ± 1.8	
	Nearby communities	16	0	3.2 ± 4.6	0.45 ± 2.2	84	4	2.1 ± 1.2	0.39 ± 1.2	
	Distant communities	8	0	1.5 ± 4.3	-0.069 ± 1.4	40	1	3.2 ± 2.9	0.39 ± 1.8	

Table 8.2.4. (contd)

Radionuclide (approximate detection limit)	Location Group[a]	2004 No. of Samples	2004 No. of Detections[b]	2004 Maximum[c] aCi/m³[g]	2004 Average[d] aCi/m³[g]	1999-2003 No. of Samples	1999-2003 No. of Detections[b]	1999-2003 Maximum[c] aCi/m³[g]	1999-2003 Average[d] aCi/m³[g]	Derived Concentration Guide[e] aCi/m³[g]
Uranium-234 (10 aCi/m³)	Site-wide	28	7	33 ± 10	-0.53 ± 41	168	160	150 ± 52	24 ± 42	90,000
	Perimeter	16	4	4.3 ± 16	-2.3 ± 46	83	83	140 ± 32	31 ± 41	
	Nearby communities	12	3	32 ± 13	-5.3 ± 45	63	62	58 ± 21	27 ± 27	
	Distant communities	8	1	14 ± 17	-12 ± 34	40	38	41 ± 15	18 ± 18	
Uranium-235 (10 aCi/m³)	Site-wide	28	0	4.0 ± 6.0	-0.58 ± 3.7	168	2	6.5 ± 8.5	0.39 ± 2.9	100,000
	Perimeter	16	0	3.2 ± 3.7	-0.54 ± 5.0	83	2	6.0 ± 6.0	0.76 ± 2.8	
	Nearby communities	12	0	1.8 ± 15	-0.84 ± 3.4	63	0	6.2 ± 5.6	0.37 ± 4.1	
	Distant communities	8	0	-1.2 ± 2.3	-2.9 ± 2.8	40	0	7.0 ± 9.3	0.26 ± 4.0	
Uranium-238 (10 aCi/m³)	Site-wide	28	26	46 ± 11	18 ± 18	168	154	160 ± 37	23 ± 43	100,000
	Perimeter	16	15	49 ± 15	22 ± 23	83	81	140 ± 32	29 ± 40	
	Nearby communities	12	11	39 ± 14	20 ± 15	63	61	56 ± 18	25 ± 24	
	Distant communities	8	7	27 ± 11	19 ± 14	40	40	33 ± 15	17 ± 15	
Cobalt-60 (1,200 aCi/m³)	Site-wide	44	0	480 ± 710	11 ± 470	259	1	3,800 ± 2,500	95 ± 880	80,000,000
	Perimeter	32	0	540 ± 860	31 ± 570	174	0	910 ± 740	18 ± 780	
	Nearby communities	28	0	770 ± 1,000	33 ± 750	154	0	1,800 ± 3,600	84 ± 880	
	Distant communities	8	0	670 ± 610	160 ± 620	43	0	730 ± 1,000	48 ± 540	
Cesium-137 (1,000 aCi/m³)	Site-wide	44	2	3,500 ± 1,500	110 ± 1,200	259	1	920 ± 690	3.8 ± 570	400,000,000
	Perimeter	32	2	4,600 ± 1,300	260 ± 1,800	174	0	1,200 ± 2,000	33 ± 600	
	Nearby communities	28	0	530 ± 670	18 ± 660	154	0	2,100 ± 3,100	16 ± 680	
	Distant communities	8	0	430 ± 690	-120 ± 560	43	0	530 ± 520	9.2 ± 570	

(a) Location groups are identified in Table 8.2.3.
(b) Detection is defined as a value reported above the minimum detectable activity and above the total propagated analytical uncertainty.
(c) Maximum single sample result ± total analytical uncertainty. Negative concentration values are explained in Appendix A.
(d) Average of all samples ±2 times the standard deviation.
(e) DOE derived concentration guide (see Appendix D, Table D.5).
(f) 1 pCi = 0.037 Bq.
(g) There are 1 million attocuries (aCi) in 1 picocurie (pCi).

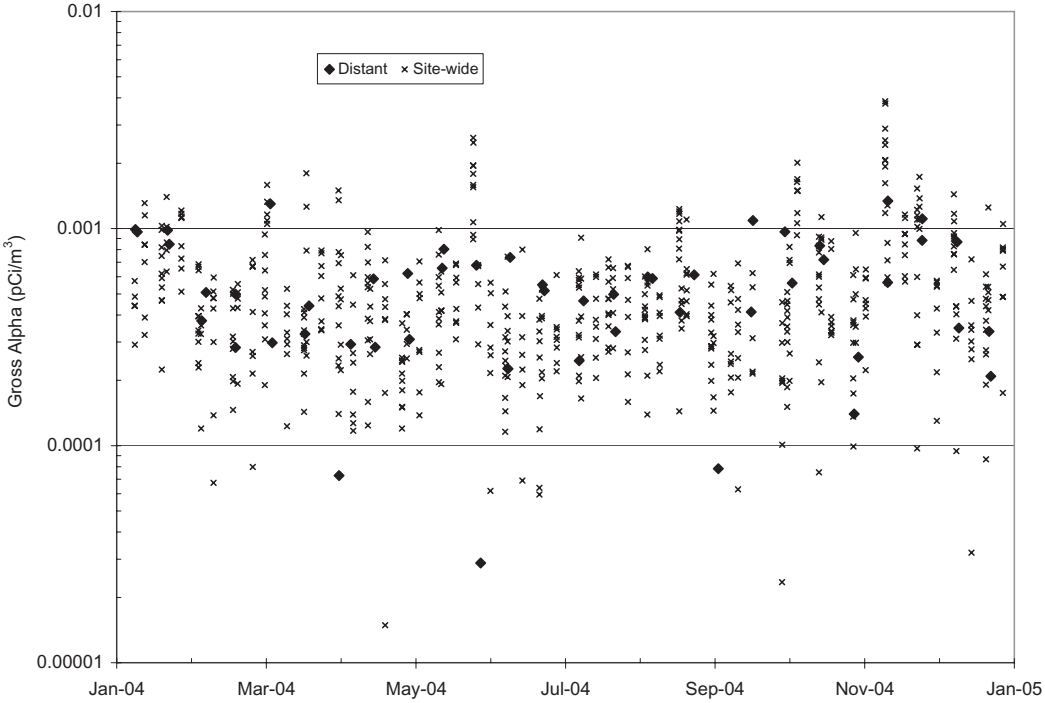

Figure 8.2.3. Gross Alpha Concentrations in Airborne Particulate Samples Collected at Hanford Site-Wide and Distant Locations During 2004 (1 pCi = 0.037 Bq)

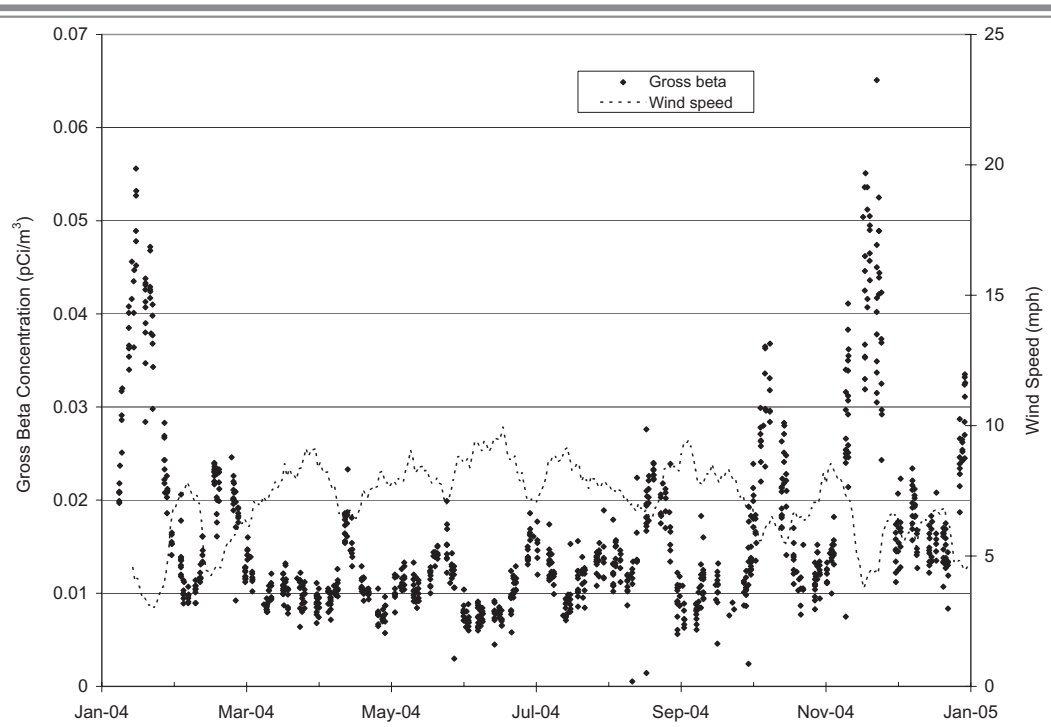

Figure 8.2.4. Gross Beta Concentrations in Airborne Particulate Samples for all Hanford Site-Wide and Offsite Sampling Locations in 2004 and Average Wind Speed over the Sampling Period (1 pCi = 0.037 Bq)

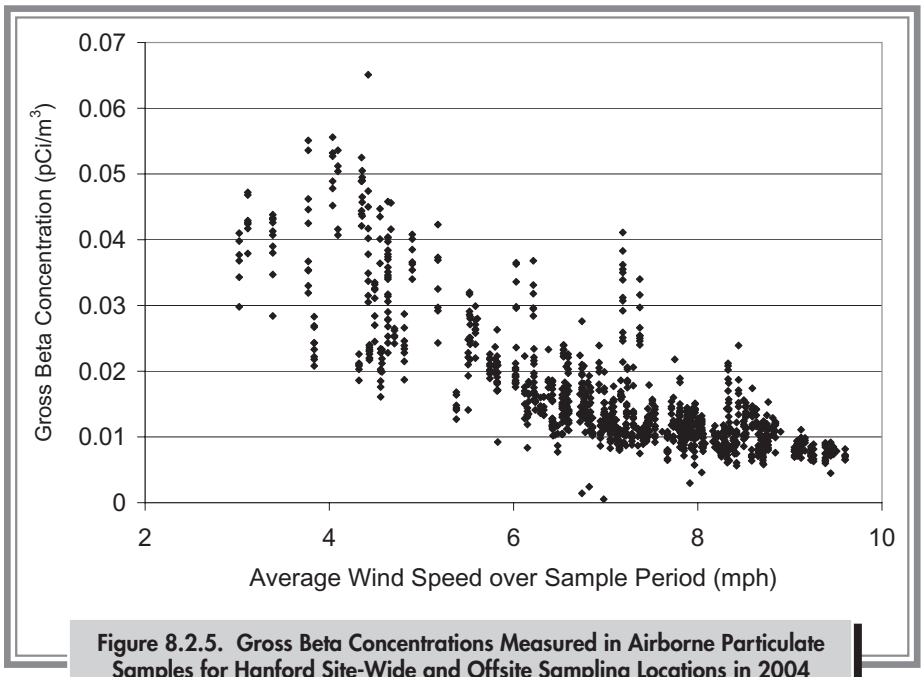

Figure 8.2.5. Gross Beta Concentrations Measured in Airborne Particulate Samples for Hanford Site-Wide and Offsite Sampling Locations in 2004 Versus the Average Wind Speed over the Sampling Period (1 pCi = 0.037 Bq)

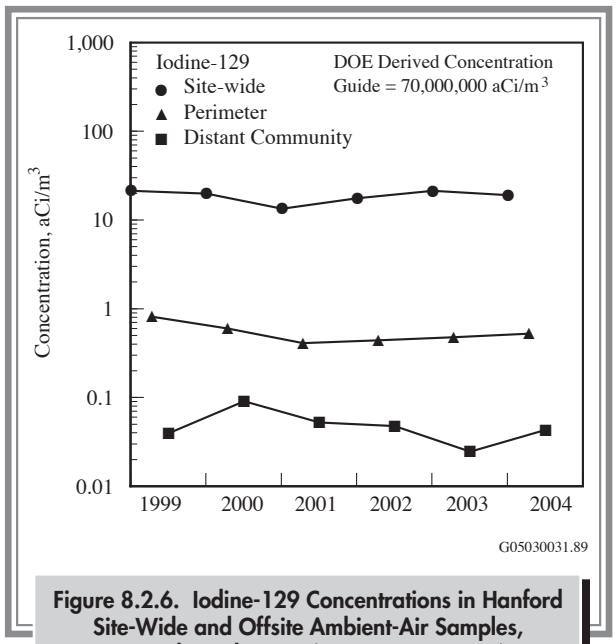

Figure 8.2.6. Iodine-129 Concentrations in Hanford Site-Wide and Offsite Ambient-Air Samples, 1999 through 2004 (1 aCi = 0.037 µBq)

Plutonium-238 was detected in four site-wide composite samples during 2004 (Table 8.2.4). The maximum reported plutonium-238 concentration in 2004 was 13 aCi/m^3 (0.48 µBq/m^3), or 2,300 times below the DOE derived concentration guide for plutonium-238 (30,000 aCi/m^3 [1,100 µBq/m^3]).

The annual average plutonium-239/240 concentration in air samples collected in 2004 at site-wide locations was 1.5 aCi/m^3 (0.056 µBq/m^3). Of the 40 site-wide samples analyzed for plutonium-239/240, 7 had detectable amounts in the sample (Table 8.2.4). Three of the detectable concentrations were from samples collected in the 100 Areas composite group (Table 8.2.3), which may have been affected by cleanup activities ongoing at various locations in the 100 Areas. Only 1 of the 52 perimeter, community, and distant samples collected in 2004 had a detectable amount of plutonium-239/240. The maximum Hanford Site plutonium-239/240 air concentration (17 aCi/m^3 [0.63 µBq/m^3]) was observed for the 300 NE fourth quarter composite group sample (locations 1, 2, and 3 on Figure 8.2.2). This sampling period included the time period covering a Category 3 environmental occurrence at the 300 Area Remediation Project (see Section 5.9.2). This event resulted in some elevated gross alpha readings in the remediation work area, and may have contributed to the maximum plutonium-239/240 air concentration measured in 2004. This maximum reported concentration was 0.09% of the DOE derived concentration guide (20,000 aCi/m^3 [730 µBq/m^3]) for plutonium-239/240.

Isotopic uranium concentrations (uranium-234, uranium-235, and uranium-238) in airborne particulate matter in 2004 were lower than average concentrations measured from 1999 through 2003 for all location groups (Table 8.2.4). The 2004 annual average uranium-238 concentration for the site perimeter was 22 aCi/m^3 (0.81 µBq/m^3), which is 0.02% of the DOE derived

concentration guide (100,000 aCi/m^3 [3,700 µBq/m^3]). The site-wide and perimeter uranium-234 and uranium-238 average concentrations were not different than the distant concentrations by a statistically significant amount (two-sample means t-test, 95% confidence level). Similar to plutonium-239/240, the highest measured uranium-238 concentration was measured at the 300 NE composite group during the fourth quarter of 2004. This sampling period included the time period when a Category 3 environmental occurrence at the 300 Area Remediation Project occurred (see Section 5.9.2). This event resulted in some elevated gross alpha readings in the remediation work area, and may have contributed to the maximum site-wide uranium-238 air concentration measured in 2004. This concentration (46 aCi/m^3 [1.7 µBq/m^3]) was only 0.05% of the DOE derived concentration guide for uranium-238.

Strontium-90 was analyzed in 92 airborne particulate samples in 2004 (Table 8.2.4). No samples had detectable concentrations. Comparison of the average concentrations was unnecessary since there were no detectable results.

Gamma spectroscopy was conducted on all quarterly composite samples collected in 2004. Naturally occurring beryllium-7 and potassium-40 were routinely identified. The potential Hanford-origin gamma-emitting radionuclides of cobalt-60 and cesium-137 were of particular interest. Four of the 112 samples analyzed by gamma spectroscopy had concentrations of cesium-137 above the minimum detectable concentration. None of the samples collected in 2004 had detectable concentrations of cobalt-60. This is consistent with the 5-year average data from 1999 though 2003 (Table 8.2.4).

8.2.2.3 Monitoring of Airborne Particulate Matter on the Hanford Site

Airborne particulate matter (dust) is one of EPA's criteria pollutants. EPA classifies particulate matter by particle size. PM_{10} is an air pollutant consisting of small particles with aerodynamic diameters less than or equal to 10 micrometers. Similarly, $PM_{2.5}$ is an air pollutant consisting of small particles with aerodynamic diameters less than or equal to 2.5 micrometers (PM_{10} particles can include $PM_{2.5}$, since particles smaller than 2.5 micrometers are also smaller than 10 micrometers). The EPA's *National Primary and Secondary Ambient Air Quality Standards* (40 CFR 50) for PM_{10} requires a 24-hour average concentration of less than 150 µg/m^3, and an annual average concentration less than 50 µg/m^3. There is currently no enforced EPA standard for $PM_{2.5}$, although proposed standards are 65 µg/m^3 for a 24-hour average concentration and a 15 µg/m^3 annual average concentration. Health risk studies have shown a positive correlation between increases in concentrations of airborne particulate matter and increased hospital admissions for pulmonary and heart conditions (Schwartz 1994; Morgan et al. 1998; Ostro et al. 1999). Studies have indicated that a 100 µg/m^3 increase in PM_{10} concentrations results in a 17% increase in hospital admissions for pneumonia and chronic obstructive pulmonary disorder (Schwartz 1994). Similar relationships were found between PM_{10} concentrations and daily human mortality in areas where windblown dust was the main contributor to high PM_{10} concentrations (similar to the Hanford Site) (Ostro et al. 1999).

During February 2001, monitoring of particulate matter mass concentrations in air on the Hanford Site began. The motivation for this was the decrease in vegetative cover on a large portion of the site after the 24 Command Hanford Site Wildfire in 2000 (*Hanford Site Environmental Report for Calendar Year 2000*, PNNL-13487), as well as information requests from the public. It was expected that the decrease in vegetative cover would result in increased wind erosion, and subsequently, increased particulate matter (dust) concentrations in air. In 2004, particulate monitoring was done at the Hanford Meteorological Station (location 45, Figure 8.2.2 and Table 8.2.3) using a tapered element oscillating microbalance. The unique design of this instrument measures the difference in mass collected on a filter by measuring the change in frequency of oscillation of the filter. The instrument records an hourly average concentration, but daily average concentration data were calculated for this report. PM_{10} concentration data have been collected at the Hanford Meteorology Station since February 2001, while $PM_{2.5}$ concentration data collection began at the Hanford Meteorology Station in October 2001.

Figure 8.2.7 illustrates the daily average PM_{10} concentrations recorded at the Hanford Meteorology Station during 2004 for all time periods when the instrument was operating. The instrument operated 79% of the time during

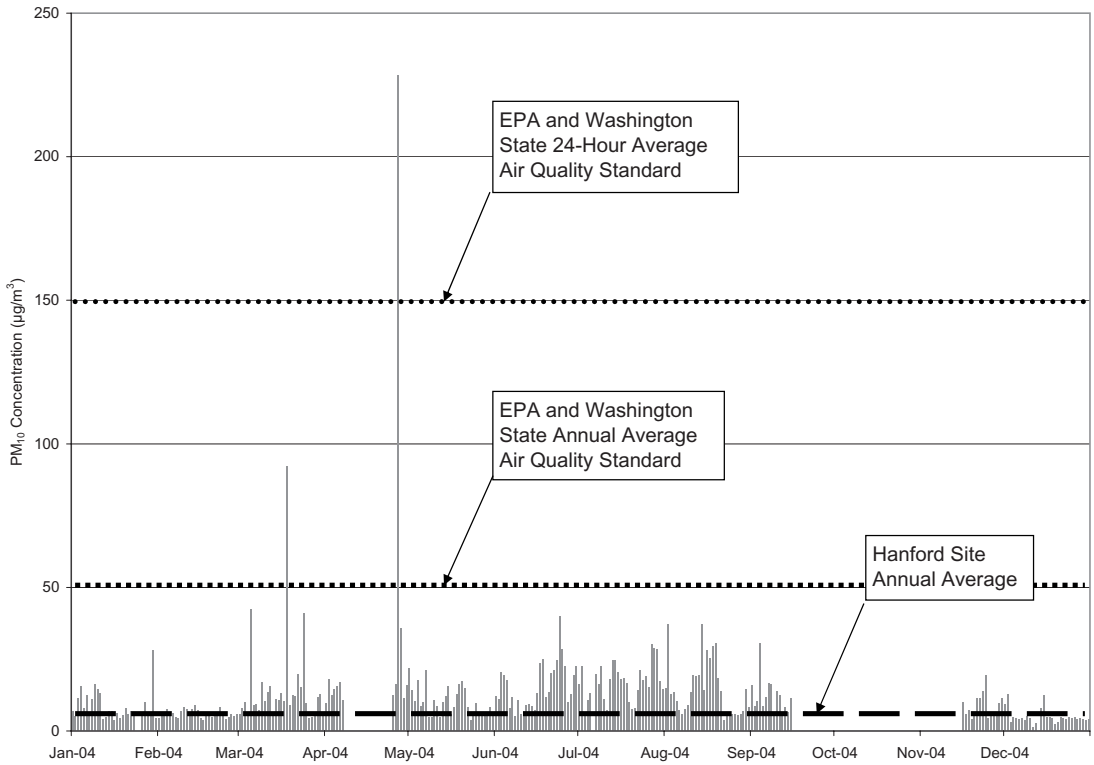

Figure 8.2.7. Daily Average PM_{10} Particle Concentrations at the Hanford Meteorology Station, 2004 (EPA 24-hour National Ambient Air Quality Standard's concentration is 150 µg/m³)

2004. Although Hanford Site measurements are not used to determine compliance with air quality standards (Section 5.3.1), EPA standards were not exceeded at the measurement locations on the Hanford Site. The observed annual average PM_{10} concentration at the Hanford Meteorology Station during 2004 (12 µg/m³) was well below the EPA annual average standard (50 µg/m³). Daily average PM_{10} concentrations on the Hanford Site were higher than the EPA 24-hour average standard once during 2004 (April 27), but EPA policy allows exemptions for natural events that result in high particulate matter concentrations, such as windstorms. Wind speeds on April 27, 2004, exceeded 22 meters per second (50 miles per hour).

There is currently no enforced EPA concentration standard for $PM_{2.5}$. However, the $PM_{2.5}$ concentrations measured at the Hanford Meteorology Station during 2004 (Figure 8.2.8) were well below the proposed EPA standards for $PM_{2.5}$ (15 µg/m³ annual average, 65 µg/m³ 24-hour average). The measured annual average $PM_{2.5}$ concentration at the Hanford Meteorology Station during 2003 was 6.5 µg/m³, while the highest 24-hour average concentration observed was 21 µg/m³.

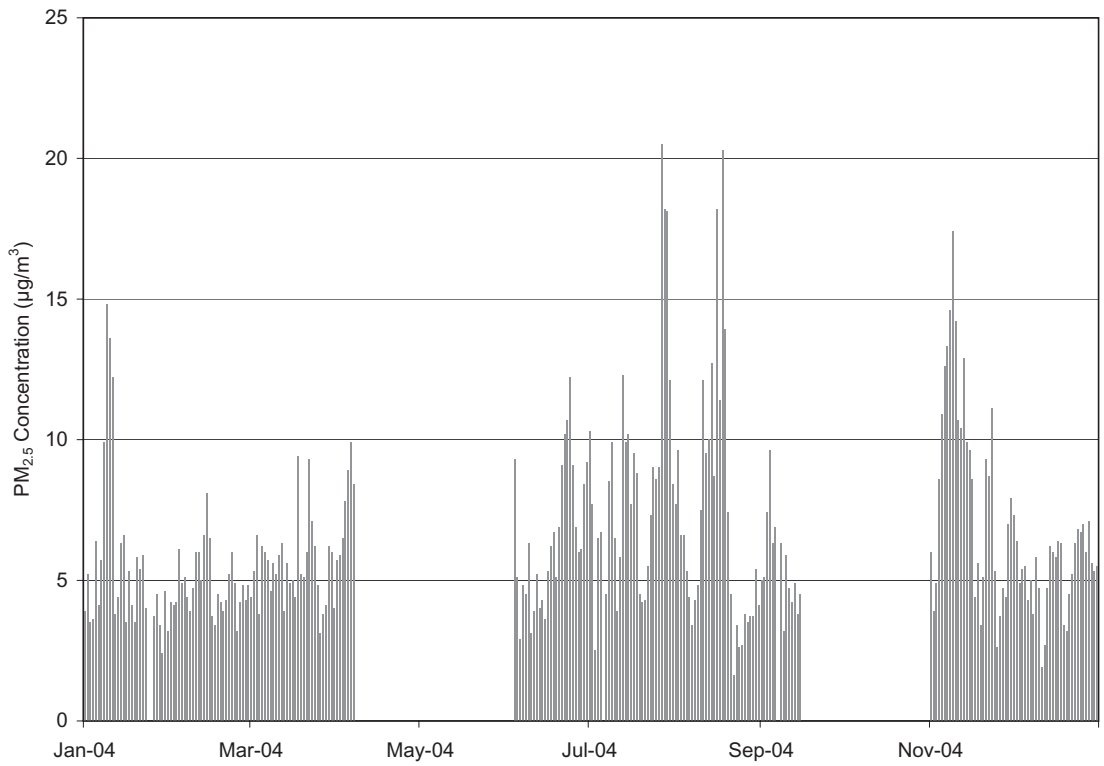

Figure 8.2.8. Daily Average $PM_{2.5}$ Concentrations at the Hanford Meteorology Station, 2004