Appendix A
Additional Monitoring Results for 1998

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This appendix contains additional information on 1998 monitoring results, supplementing the data summarized in the main body of the report. More detailed information is available in PNNL-12088, APP. 1.

Table A.1. Radionuclide Activities in Columbia River Water at Priest Rapids Dam, 1998 Compared to Previous 5 Years

Radionuclide[a]	1998 No. of Samples	1998 Activity,[b] pCi/L Maximum	1998 Activity,[b] pCi/L Average	1993-1997 No. of Samples	1993-1997 Activity,[b] pCi/L Maximum	1993-1997 Activity,[b] pCi/L Average	Ambient Surface Water Quality Standard, pCi/L
Composite System							
Tritium	10	62[c] ± 12	36 ± 7.2	60	51 ± 9.4	34 ± 1.7	20,000[d]
Alpha (gross)	12	1.6 ± 0.83	0.49 ± 0.26	60	1.2 ± 0.86	0.41 ± 0.088	15[e,f]
Beryllium-7	12	17 ± 15	0.74 ± 5.0	60	18 ± 15	1.6 ± 2.0	6,000[d]
Beta (gross)	12	2.3 ± 1.5	1.1 ± 0.36	60	3.5 ± 2.4	0.93 ± 0.30	50[e,f]
Potassium-40	12	120 ± 58	38 ± 28	60	280 ± 54	48 ± 12	--[g]
Cobalt-60	12	3.0 ± 1.9	0.21 ± 0.76	60	1.6 ± 0.99	0.016 ± 0.22	100[d]
Strontium-90	12	0.11 ± 0.038	0.080 ± 0.0076	60	0.14 ± 0.0049	0.086 ± 0.0060	8[e,f]
Technetium-99	12	0.21 ± 0.49	0.026 ± 0.076	60	1.6 ± 0.69	0.026 ± 0.072	900[d]
Iodine-129[h]	3	0.000020 ± 0.0000027	0.000015 ± 0.0000094	21	0.00013 ± 0.000013	0.000014 ± 0.000012	1[d]
Ruthenium-106	12	20 ± 22	6.5 ± 4.4	43	12 ± 22	-0.70 ± 2.2	30[d]
Antimony-125	12	4.3 ± 6.2	-0.74 ± 1.5	43	6.4 ± 5.6	-0.50 ± 0.64	300[d]
Cesium-134	12	2.6 ± 2.1	0.075 ± 0.68	60	2.8 ± 2.4	0.030 ± 0.22	20,000[d]
Cesium-137	12	3.5 ± 2.4	0.64 ± 0.76	60	2.0 ± 2.3	0.15 ± 0.18	200[d]
Europium-154	12	5.5 ± 6.6	-1.2 ± 2.2	60	5.2 ± 2.9	0.035 ± 0.64	200[d]
Europium-155	12	4.8 ± 3.9	-0.52 ± 1.5	60	5.8 ± 4.7	0.097 ± 0.46	600[d]
Uranium-234	12	0.38 ± 0.068	0.26 ± 0.030	60	0.44 ± 0.13	0.24 ± 0.014	--
Uranium-235	12	0.024 ± 0.014	0.0082 ± 0.0048	60	0.032 ± 0.039	0.0091 ± 0.0020	--
Uranium-238	12	0.32 ± 0.062	0.22 ± 0.028	60	0.35 ± 0.11	0.19 ± 0.012	--
Uranium (total)	12	0.71 ± 0.14	0.48 ± 0.056	60	0.83 ± 0.28	0.43 ± 0.026	--
Continuous System							
Plutonium-230,240 P	4	0.00028 ± 0.00011	0.000099 ± 0.00012	21	0.00015 ± 0.000098	0.000036 ± 0.000016	--
D	4	0.000040 ± 0.000060	0.000015 ± 0.000018	21	0.00063 ± 0.00021	0.000055 ± 0.000064	--

(a) Radionuclides measured using the continuous system show the particulate (P) and dissolved (D) fractions separately. Other radionuclides are based on unfiltered samples collected by the composite system (see Section 4.2, "Surface Water and Sediment Surveillance").
(b) Maximum values are ± total propagated analytical uncertainty (2 sigma). Averages are ±2 standard error of the calculated mean.
(c) Excludes one result of 200 ± 22 pCi/L.
(d) WAC 173-201A-050 and EPA-570/9-76-003.
(e) WAC 246-290.
(f) 40 CFR 141.
(g) Dashes indicate no concentration guides available.
(h) From 1993 through 1995, iodine-129 activities were obtained from the dissolved fraction of the continuous system.

Table A.2. Radionuclide Activities in Columbia River Water at the Richland Pumphouse, 1998 Compared to Previous 5 Years

Radionuclide[a]	1998 No. of Samples	1998 Activity,[b] pCi/L Maximum	1998 Activity,[b] pCi/L Average	1993-1997 No. of Samples	1993-1997 Activity,[b] pCi/L Maximum	1993-1997 Activity,[b] pCi/L Average	Ambient Surface Water Quality Standard, pCi/L
Composite System							
Tritium	10	150 ± 18	76 ± 21	60	160 ± 19	79 ± 7.4	20,000[c]
Alpha (gross)	12	0.86 ± 0.61	0.47 ± 0.12	60	2.2 ± 1.1	0.60 ± 0.12	15[c,d]
Beryllium-7	12	26 ± 26	1.4 ± 7.0	60	20 ± 12	1.5 ± 2.0	6,000[e]
Beta (gross)	12	2.2 ± 2.0	0.68 ± 0.50	60	3.4 ± 1.7	1.0 ± 0.24	50[c,d]
Potassium-40	12	200 ± 52	67 ± 42	60	240 ± 61	48 ± 9.4	--[f]
Cobalt-60	12	4.1 ± 2.2	-0.44 ± 1.1	60	1.7 ± 2.1	0.059 ± 0.22	100[e]
Strontium-90	12	0.098 ± 0.036	0.077 ± 0.0092	60	0.30 ± 0.081	0.088 ± 0.0092	8[c,d]
Technetium-99	12	0.53 ± 0.52	0.12 ± 0.12	60	0.31 ± 0.56	0.019 ± 0.040	900[e]
Iodine-129[g]	4	0.00016 ± 0.000020	0.00012 ± 0.000042	18	0.00016 ± 0.000013	0.00010 ± 0.000020	1[e]
Ruthenium-106	12	19 ± 20	1.0 ± 6.2	43	13 ± 18	0.46 ± 2.2	30[e]
Antimony-125	12	5.0 ± 5.5	1.7 ± 1.4	43	6.0 ± 4.7	0.17 ± 0.56	300[e]
Cesium-134	12	1.4 ± 2.2	-0.88 ± 1.1	60	1.1 ± 0.89	-0.10 ± 0.18	20,000[e]
Cesium-137	12	3.1 ± 2.2	0.23 ± 0.82	60	3.7 ± 2.1	0.34 ± 0.20	200[e]
Europium-154	12	8.8 ± 5.4	1.4 ± 2.4	60	4.1 ± 3.4	-0.20 ± 0.50	200[e]
Europium-155	12	3.4 ± 4.2	1.2 ± 0.84	60	3.4 ± 4.6	-0.020 ± 0.40	600[e]
Uranium-234	12	0.37 ± 0.070	0.29 ± 0.024	60	0.50 ± 0.13	0.27 ± 0.020	--
Uranium-235	12	0.024 ± 0.015	0.010 ± 0.0048	60	0.048 ± 0.022	0.0098 ± 0.0022	--
Uranium-238	12	0.30 ± 0.060	0.23 ± 0.026	60	0.53 ± 0.14	0.22 ± 0.0022	--
Uranium (total)	12	0.68 ± 0.14	0.53 ± 0.040	60	1.0 ± 0.30	0.50 ± 0.036	--
Continuous System							
Plutonium-239,240 P	4	0.00017 ± 0.000087	0.000066 ± 0.000068	18	0.00015 ± 0.000051	0.000034 ± 0.000017	--
D	4	0.000052 ± 0.000058	0.000038 ± 0.000011	18	0.00020 ± 0.00012	0.000050 ± 0.000024	--

(a) Radionuclides measured using the continuous system show the particulate (P) and dissolved (D) fractions separately. Other radionuclides are based on unfiltered samples collected by the composite system (see Section 4.2, "Surface Water and Sediment Surveillance").
(b) Maximum values are ± total propagated analytical uncertainty (2 sigma). Averages are ±2 standard error of the calculated mean.
(c) 40 CFR 141.
(d) WAC 246-290.
(e) WAC 173-201A-050 and EPA-570/9-76-003.
(f) Dashes indicate no concentration guides available.
(g) From 1993 through 1995, iodine-129 activities were obtained from the dissolved fraction of the continuous system.

Table A.3. Radionuclide Activities Measured in Columbia River Water Along Transects of the Hanford Reach, 1998

Transect/Radionuclide	No. of Samples	Activity,[a] pCi/L Maximum	Minimum	Mean
Vernita Bridge				
Tritium	12	85 ± 13	26 ± 7.9	49 ± 11
Strontium-90	16	0.15 ± 0.052	0.045 ± 0.029	0.080 ± 0.011
Uranium (total)	16	0.60 ± 0.15	0.33 ± 0.083	0.44 ± 0.034
100-N Area				
Tritium	7	61 ± 12	33 ± 10	45 ± 5.4
Strontium-90	10	0.088 ± 0.034	0.053 ± 0.042	0.072 ± 0.0068
Uranium (total)	10	0.45 ± 0.11	0.34 ± 0.083	0.40 ± 0.024
100-F Area				
Tritium	10	96 ± 14	39 ± 9.7	52 ± 11
Strontium-90	10	0.11 ± 0.037	0.020 ± 0.021	0.076 ± 0.015
Uranium (total)	10	0.46 ± 0.099	0.33 ± 0.084	0.40 ± 0.026
Old Hanford Townsite				
Tritium	10	4,100 ± 350	53 ± 10	730 ± 910
Strontium-90	10	0.086 ± 0.034	0.055 ± 0.027	0.072 ± 0.0070
Uranium (total)	10	0.58 ± 0.12	0.30 ± 0.086	0.42 ± 0.050
300 Area				
Tritium	10	63 ± 11	34 ± 8.4	42 ± 5.6
Strontium-90	10	0.11 ± 0.053	-0.22 ± 0.33	0.046 ± 0.060
Uranium (total)	8	0.77 ± 0.25	0.26 ± 0.15	0.43 ± 0.11
Richland Pumphouse				
Tritium	30	99 ± 13	23 ± 7.6	52 ± 3.7
Strontium-90	42	0.11 ± 0.056	0.042 ± 0.030	0.074 ± 0.0050
Uranium (total)	42	0.88 ± 0.16	0.34 ± 0.094	0.50 ± 0.034

(a) Maximum and minimum values are ± total propagated analytical uncertainty (2 sigma). Mean values are ±2 standard error of the mean.

Table A.4. Selected U.S. Geological Survey Columbia River Water Quality Data,[a] 1998

Analysis	Units	Vernita Bridge (upstream) No. of Samples	Median	Maximum	Minimum	Richland Pumphouse (downstream) No. of Samples	Median	Maximum	Minimum	Washington Ambient Surface Water Quality Standard[b]
Temperature	°C	10	12	20	4.0	4	11	20	5.5	20 (maximum)
Dissolved oxygen	mg/L	10	12	13	9.3	4	11	13	9.1	8 (minimum)
Turbidity	NTU[c]	10	0.50	1.6	0.30	4	0.8	1.8	0.6	5 + background
pH	pH units	10	8.0	8.1	7.8	4	7.9	8.1	7.8	6.5 - 8.5
Suspended solids, 105°C (221°F)	mg/L	10	2.0	4	<0.5	4	4.0	10	2.0	--[d]
Dissolved solids, 180°C (356°F)	mg/L	10	81	97	72	4	84	92	80	--
Specific conductance	µS/cm	10	140	150	110	4	150	150	130	--
Total hardness, as $CaCO_3$	mg/L	10	63	69	50	4	64	71	59	--
Phosphorus, total	mg/L	10	<0.05	0.02	<0.01	4	<0.03	0.01	<0.01	--
Chromium, dissolved	µg/L	8	<1	2	<1	4	<1	<1	<1	--
Dissolved organic carbon	mg/L	10	1.3	2.1	1.1	4	1.2	1.8	1.1	--
Iron, dissolved	µg/L	10	<10	24	<10	4	<10	<10	<10	--
Ammonia, dissolved, as N	mg/L	10	<0.002	0.002	<0.002	4	<0.02	0.06	<0.02	--
Nitrogen, total Kjeldahl, as N	mg/L	10	<0.1	0.2	<0.1	4	<0.1	0.1	<0.1	--
Nitrite + nitrate, dissolved, as N	mg/L	10	0.092	0.17	0.033	4	0.14	0.17	0.090	--

(a) Provisional data from U.S. Geological Survey National Stream Quality Accounting Network (NASQAN), subject to revision.
(b) From WAC 173-201A.
(c) NTU = nephelometric turbidity units.
(d) Dashes indicate no standard available.

Table A.5. Radionuclide Activities in Sediments from the Columbia and Snake Rivers and from Columbia River Shoreline Springs, 1998 Compared to Previous 5 Years

Location	Radionuclide	1998 No. of Samples	1998 Activity, pCi/g Median[a]	1998 Activity, pCi/g Maximum[b]	1993-1997 No. of Samples	1993-1997 Activity, pCi/g Median[a]	1993-1997 Activity, pCi/g Maximum[b]
River Sediment							
100-F Slough	Cobalt-60	1		0.023 ± 0.010	6	0.026	0.033 ± 0.011
	Cesium-137	1		0.36 ± 0.042	6	0.43	0.49 ± 0.054
	Europium-155	1		0.028 ± 0.030	6	0.028	0.061 ± 0.033
	Plutonium-239,240	1		0.0017 ± 0.00038	6	0.0018	0.0024 ± 0.00082
	Strontium-90	1		0.0052 ± 0.0037	6	0.0034	0.013 ± 0.0052
	Uranium-235	1		0.0022 ± 0.0052	6	0.022	0.064 ± 0.068
	Uranium-238	1		0.10 ± 0.022	6	0.94	1.4 ± 0.41
Hanford Slough	Cobalt-60	1		0.011 ± 0.011	6	0.14	0.32 ± 0.046
	Cesium-137	1		0.13 ± 0.021	6	0.41	0.59 ± 0.068
	Europium-155	1		0.067 ± 0.036	6	0.080	0.16 ± 0.075
	Plutonium-239,240	1		0.0014 ± 0.00039	6	0.0047	0.0076 ± 0.0014
	Strontium-90	1		0.0036 ± 0.0036	6	0.0084	0.017 ± 0.0052
	Uranium-235	1		0.0090 ± 0.0068	6	0.064	0.24 ± 0.16
	Uranium-238	1		0.27 ± 0.044	6	1.2	2.4 ± 0.88
McNary Dam	Cobalt-60	6	0.048	0.063 ± 0.035	24	0.058	0.26 ± 0.033
	Cesium-137	6	0.36	0.81 ± 0.090	24	0.46	1.0 ± 0.11
	Europium-155	6	0.056	0.085 ± 0.058	24	0.055	0.13 ± 0.069
	Plutonium-239,240	6	0.0084	0.013 ± 0.0019	24	0.0081	0.014 ± 0.0026
	Strontium-90	6	0.020	0.039 ± 0.010	24	0.024	0.049 ± 0.011
	Uranium-235	6	0.028	0.030 ± 0.011	24	0.066	0.21 ± 0.10
	Uranium-238	6	0.62	0.67 ± 0.086	24	1.5	2.3 ± 0.71
Priest Rapids Dam	Cobalt-60	6	-0.0011	0.026 ± 0.015	23	0.0020	0.038 ± 0.049
	Cesium-137	6	0.32	0.52 ± 0.065	23	0.41	1.0 ± 0.14
	Europium-155	6	0.061	0.076 ± 0.043	23	0.049	0.10 ± 0.050
	Plutonium-239,240	6	0.0081	0.013 ± 0.0032	23	0.0082	0.018 ± 0.0032
	Strontium-90	6	0.015	0.019 ± 0.0074	23	0.014	0.025 ± 0.0068
	Uranium-235	6	0.016	0.028 ± 0.012	23	0.079	0.32 ± 0.17
	Uranium-238	6	0.44	0.70 ± 0.087	23	0.99	2.2 ± 0.71

Table A.5. (contd)

Location	Radionuclide	1998 No. of Samples	1998 Activity, pCi/g Median[a]	1998 Activity, pCi/g Maximum[b]	1993-1997 No. of Samples	1993-1997 Activity, pCi/g Median[a]	1993-1997 Activity, pCi/g Maximum[b]
Ice Harbor Dam (Snake River)	Cobalt-60	3	-0.016	-0.0022 ± 0.014	0		
	Cesium-137	3	0.23	0.29 ± 0.044	0		
	Europium-155	3	0.079	0.081 ± 0.044	0		
	Plutonium-239,240	3	0.0085	0.0087 ± 0.0019	0		
	Strontium-90	3	0.018	0.019 ± 0.0095	0		
	Uranium-235	3	0.018	0.027 ± 0.011	0		
	Uranium-238	3	0.66	0.73 ± 0.090	0		
Richland	Cobalt-60	1		0.012 ± 0.013	5	0.051	0.074 ± 0.019
	Cesium-137	1		0.086 ± 0.018	5	0.30	0.34 ± 0.042
	Europium-155	1		0.028 ± 0.037	5	0.059	0.066 ± 0.034
	Plutonium-239,240	1		0.0014 ± 0.00061	5	0.0020	0.0034 ± 0.00073
	Strontium-90	1		0.0041 ± 0.0042	5	0.0027	0.0050 ± 0.0035
	Uranium-235	1		0.014 ± 0.0080	5	0.053	0.14 ± 0.080
	Uranium-238	1		0.24 ± 0.039	5	1.1	2.1 ± 0.54
White Bluffs Slough	Cobalt-60	1		0.11 ± 0.024	6	0.081	0.20 ± 0.031
	Cesium-137	1		0.60 ± 0.067	6	0.80	0.97 ± 0.11
	Europium-155	1		0.10 ± 0.034	6	0.051	0.065 ± 0.034
	Plutonium-239,240	1		0.0050 ± 0.0012	6	0.0040	0.0073 ± 0.0017
	Strontium-90	1		0.0082 ± 0.0049	6	0.0055	0.017 ± 0.0055
	Uranium-235	1		0.0087 ± 0.0063	6	0.019	0.16 ± 0.12
	Uranium-238	1		0.26 ± 0.041	6	1.2	1.9 ± 0.52
Riverbank Springs Sediment							
100-B Spring	Cobalt-60	1		0.021 ± 0.015	3	0.029	0.051 ± 0.024
	Cesium-137	1		0.10 ± 0.023	3	0.079	0.095 ± 0.015
	Europium-155	1		0.11 ± 0.072	3	0.065	0.074 ± 0.036
	Strontium-90	1		0.0041 ± 0.0083	3	0.0027	0.0041 ± 0.0050
	Uranium-235	1		0.029 ± 0.016	3	0.10	0.20 ± 0.10
	Uranium-238	1		0.26 ± 0.055	3	1.2	1.2 ± 0.38

Table A.5. (contd)

Location	Radionuclide	1998 No. of Samples	1998 Activity, pCi/g Median[a]	1998 Activity, pCi/g Maximum[b]	1993-1997 No. of Samples	1993-1997 Activity, pCi/g Median[a]	1993-1997 Activity, pCi/g Maximum[b]
100-F Spring	Cobalt-60	1		0.016 ± 0.0071	3	0.040	0.044 ± 0.024
	Cesium-137	1		0.14 ± 0.019	3	0.19	0.32 ± 0.040
	Europium-155	1		0.024 ± 0.025	3	0.037	0.055 ± 0.031
	Strontium-90	1		0.0041 ± 0.0071	3	0.0087	0.0096 ± 0.010
	Uranium-235	1		0.022 ± 0.0095	3	0.16	0.17 ± 0.13
	Uranium-238	1		0.43 ± 0.059	3	1.2	1.4 ± 0.54
100-K Spring	Cobalt-60	(c)			2	0.011	0.015 ± 0.021
	Cesium-137	(c)			2	0.17	0.19 ± 0.046
	Europium-155	(c)			2	0.084	0.13 ± 0.066
	Strontium-90	(c)			2	0.0049	0.0085 ± 0.0048
	Uranium-235	(c)			2	0.17	0.20 ± 0.14
	Uranium-238	(c)			2	1.2	1.5 ± 0.54
300 Area Spring	Cobalt-60	(d)			5	0.013	0.016 ± 0.0076
	Cesium-137	(d)			5	0.074	0.15 ± 0.026
	Europium-155	(d)			5	0.045	0.13 ± 0.14
	Strontium-90	(d)			5	0.0073	0.012 ± 0.0060
	Uranium-235	(d)			5	0.12	0.41 ± 0.16
	Uranium-238	(d)			5	3.2	5.2 ± 1.1
Hanford Spring	Cobalt-60	(c)			5	0.059	0.090 ± 0.021
	Cesium-137	(c)			5	0.25	0.29 ± 0.032
	Europium-155	(c)			5	0.062	0.068 ± 0.034
	Strontium-90	(c)			5	0.0068	0.0086 ± 0.011
	Uranium-235	(c)			5	0.023	0.23 ± 0.14
	Uranium-238	(c)			5	1.3	1.9 ± 0.54

(a) Median values are not provided when only one sample analyzed.
(b) Values are ± total propagated analytical uncertainty (2 sigma).
(c) Sediment was not available at the 1998 spring location.
(d) Sample was collected but not analyzed.

Table A.6. Median Metal Concentrations (mg/kg dry wt.) in Columbia and Snake River Sediments, 1998

Metal	Priest Rapids Dam	Hanford Reach[a]	McNary Dam	Ice Harbor Dam (Snake River)	Riverbank Springs[b]
Antimony	0.63	0.50	0.70	0.67	0.77
Arsenic	3.8	3.6	6.9	7.4	6.8
Beryllium	0.84	1.2	1.2	1.4	2.9
Cadmium	5.8	0.86	1.8	0.19	1.6
Chromium	55	46	53	46	82
Copper	38	25	33	30	22
Lead	31	32	22	15	31
Mercury	0.12	0.057	0.10	0.043	0.014
Nickel	33	20	28	22	23
Selenium	0.52	0.47	0.42	0.45	<1.6
Silver	0.10	0.074	0.13	0.072	0.077
Thalium	1.4	0.79	0.80	0.41	0.88
Zinc	460	260	210	120	260

(a) 100-F Slough, Hanford Slough, Richland, and White Bluffs Slough.
(b) 100-B and 100-F Area.

Table A.7. Radionuclide Activities Measured in Riverbank Springs Water, 1998 Compared to Previous 5 Years

Location/Radionuclide	1998 No. of Samples	1998 Activity,[a] pCi/L Maximum	1993-1997 No. of Samples	1993-1997 Activity,[a] pCi/L Maximum	1993-1997 Activity,[a] pCi/L Median	Washington State Ambient Surface Water Quality Standard,[b] pCi/L
100-B Spring						
Alpha (gross)	1	1.6 ± 1.7	7	3.5 ± 1.8	1.4	15
Beta (gross)	1	7.6 ± 2.7	7	38 ± 4.6	10	50
Strontium-90	1	-0.022 ± 0.067	7	0.072 ± 0.11	0.023	8
Technetium-99	1	10 ± 1.4	7	25 ± 3.2	10	900[c]
Tritium	1	14,000 ± 1,100	7	24,000 ± 1,800	14,000	20,000
100-D Spring						
Alpha (gross)	1	0.98 ± 1.4	8	2.9 ± 1.9	1.1	15
Beta (gross)	1	14 ± 3.6	8	21 ± 3.3	9.1	50
Strontium-90	1	5.3 ± 1.2	8	9.4 ± 1.8	4.1	8
Tritium	1	4,800 ± 450	8	12,000 ± 1,000	6,200	20,000
100-F Spring						
Alpha (gross)	1	4.0 ± 2.0	4	41 ± 18	3.4	15
Beta (gross)	1	5.7 ± 2.5	4	65 ± 11	2.9	50
Strontium-90	1	0.012 ± 0.024	4	0.099 ± 0.091	0.064	8
Tritium	1	740 ± 170	4	1,800 ± 240	1,400	20,000
Uranium (total)	1	3.1 ± 0.40	4	9.2 ± 1.2	4.6	--[d]
100-H Spring						
Alpha (gross)	1	10 ± 3.7	6	4.6 ± 1.9	4.1	15
Beta (gross)	1	72 ± 8.6	6	69 ± 7.0	55	50
Strontium-90	1	[e]	6	25 ± 4.5	17	8
Technetium-99	1	77 ± 8.7	6	140 ± 15	87	900
Tritium	1	2,300 ± 270	6	1,200 ± 240	1,100	20,000
Uranium (total)	1	9.3 ± 1.0	6	8.4 ± 1.2	6.1	--
100-K Spring						
Alpha (gross)	1	3.2 ± 1.8	4	1.6 ± 1.2	0.98	15
Beta (gross)	1	5.0 ± 2.4	4	3.6 ± 2.5	2.3	50
Strontium-90	1	0.035 ± 0.016	4	0.59 ± 0.13	0.041	8
Tritium	1	12,000 ± 970	4	20,000 ± 1,500	18,000	20,000

Table A.7. (contd)

Location/Radionuclide	1998 No. of Samples	1998 Activity,[a] pCi/L Maximum	1993-1997 No. of Samples	1993-1997 Activity,[a] pCi/L Maximum	1993-1997 Activity,[a] pCi/L Median	Washington State Ambient Surface Water Quality Standard,[b] pCi/L
100-N Spring (8-13)[f]						
Alpha (gross)	1	1.3 ± 1.3	6	8.1 ± 3.3	1.1	15
Beta (gross)	1	2.3 ± 2.1	6	8.8 ± 2.3	4.0	50
Strontium-90	1	[e]	6	0.59 ± 0.3	0.066	8
Tritium	1	24,000 ± 1,900	6	31,000 ± 2,400	24,000	20,000
300 Area Spring						
Alpha (gross)	1	56 ± 10	7	110 ± 21	45	15
Beta (gross)	1	21 ± 4.1	7	21 ± 3.3	9.6	50
Iodine-129	1	0.0055 ± 0.00058	4	0.0049 ± 0.00063	0.0033	1
Technetium-99	1	13 ± 1.7	7	14 ± 1.9	8.8	900[c]
Tritium	1	9,600 ± 800	7	12,000 ± 940	9,800	20,000
Uranium (total)	1	58 ± 6.1	7	110 ± 13	61	--
Old Hanford Townsite Spring						
Alpha (gross)	1	3.2 ± 2.2	7	4.9 ± 2.2	1.2	15
Beta (gross)	1	23 ± 4.3	7	95 ± 140	18	50
Iodine-129	1	0.14 ± 0.0081	5	0.22 ± 0.014	0.086	1
Technetium-99	1	100 ± 12	7	130 ± 16	43	900[c]
Tritium	1	120,000 ± 8,800	7	170,000 ± 13,000	56,000	20,000
Uranium (total)	1	3.4 ± 0.43	7	4.3 ± 0.52	2.5	--

(a) Maximum values are ± total propagated analytical uncertainty (2 sigma).
(b) WAC 246-290, 40 CFR 141, and Appendix C, Table C.2.
(c) WAC 173-201A-050 and EPA-570/9-76-003.
(d) Dashes indicate no concentration guides available.
(e) Sample was destroyed during processing at the analytical laboratory.
(f) Refer to Table 4.2.4 for additional details on 100-N Spring samples.

Table A.8. Activities of Selected Radionuclides (pCi/g dry wt.) in Soil, 1998 Compared to Previous 6 Years

		1998				1992-1997			
Location	Radionuclide	No. of Samples	Mean[a]	Minimum[b]	Maximum[c]	No. of Samples	Mean[a]	Minimum[b]	Maximum[c]
Onsite	^{241}Am	4	0.079 ± 0.057	0.002 ± 0.001	0.24 ± 0.14	6	0.01 ± 0.006	0.0008 ± 0.002	0.037 ± 0.006
	$^{239,240}Pu$	13	0.074 ± 0.047	0.0004 ± 0.0002	0.53 ± 0.057	38	0.027 ± 0.012	0.00038 ± 0.0076	0.39 ± 0.38
	^{238}Pu	13	0.0008 ± 0.0006	0.0000 ± 0.0001	0.0081 ± 0.0013	38	0.0005 ± 0.0001	-0.00046 ± 0.0008	0.0039 ± 0.0007
	^{137}Cs	13	0.33 ± 0.14	0.01 ± 0.01	1.8 ± 0.18	38	1.1 ± 0.41	0.0031 ± 0.029	12.3 ± 1.25
	^{90}Sr	13	0.1 ± 0.031	0.014 ± 0.005	0.38 ± 0.069	41	0.16 ± 0.023	0.028 ± 0.0079	0.7 ± 0.13
	$^{238}U_{leps}$[d]					38	0.71 ± 0.043	0.32 ± 0.2	1.5 ± 0.29
	$^{239}U_{iso}$[e]	13	0.15 ± 0.01	0.11 ± 0.02	0.25 ± 0.04	3	0.26 ± 0.053	0.17 ± 0.02	0.36 ± 0.04
Perimeter	^{241}Am	1			0.003 ± 0.0015	5	0.011 ± 0.0097	0.00029 ± 0.0015	0.05 ± 0.018
	$^{239,240}Pu$	6	0.0086 ± 0.0011	0.0057 ± 0.001	0.012 ± 0.002	23	0.0079 ± 0.001	0.0006 ± 0.0004	0.021 ± 0.0029
	^{238}Pu	6	0.0003 ± 0.0001	0.00015 ± 0.0001	0.0004 ± 0.0002	23	0.0003 ± 0.0001	-0.0007 ± 0.001	0.0011 ± 0.0013
	^{137}Cs	6	0.24 ± 0.032	0.16 ± 0.024	0.34 ± 0.04	28	0.35 ± 0.047	0.014 ± 0.026	0.95 ± 0.12
	^{90}Sr	6	0.052 ± 0.005	0.033 ± 0.008	0.067 ± 0.015	28	0.078 ± 0.008	0.013 ± 0.006	0.15 ± 0.032
	$^{238}U_{leps}$[d]					23	0.71 ± 0.05	0.15 ± 0.46	1.1 ± 0.51
	$^{239}U_{iso}$[e]	6	0.17 ± 0.03	0.12 ± 0.02	0.3 ± 0.05	13	0.54 ± 0.07	0.18 ± 0.021	0.84 ± 0.10
Distant	^{241}Am	1			0.004 ± 0.002	3	0.024 ± 0.019	0.0041 ± 0.0056	0.063 ± 0.019
	$^{239,240}Pu$	1			0.006 ± 0.001	5	0.009 ± 0.0024	0.002 ± 0.0005	0.017 ± 0.0021
	^{238}Pu	1			0.0001 ± 0.0002	5	0.0004 ± 0.0001	0.0002 ± 0.0002	0.0007 ± 0.0003
	^{137}Cs	1			0.18 ± 0.03	5	0.51 ± 0.059	0.42 ± 0.053	0.74 ± 0.083
	^{90}Sr	1			0.081 ± 0.017	5	0.1 ± 0.036	0.038 ± 0.0087	0.24 ± 0.055
	$^{238}U_{leps}$[d]					5	0.74 ± 0.035	0.66 ± 0.32	0.84 ± 0.3
	$^{239}U_{iso}$[e]	1			0.1 ± 0.02				
ALE[f]	^{241}Am					2	0.001 ± 0.0003	0.0007 ± 0.0011	0.0013 ± 0.0013
	$^{239,240}Pu$	2	0.0042 ± 0.034	0.0009 ± 0.0005	0.0076 ± 0.0012	2	0.0049 ± 0.0006	0.0043 ± 0.001	0.0055 ± 0.0011
	^{238}Pu	2	0.0002 ± 0.0002	-0.0000 ± 0.0001	0.0004 ± 0.0002	2	0.00014 ± 0.0001	0.000053 ± 0.00013	0.00022 ± 0.00018
	^{137}Cs	2	0.11 ± 0.09	0.02 ± 0.01	0.21 ± 0.03	2	0.21 ± 0.12	0.20 ± 0.05	0.22 ± 0.05
	^{90}Sr	2	0.046 ± 0.034	0.012 ± 0.004	0.08 ± 0.018	2	0.089 ± 0.007	0.082 ± 0.017	0.097 ± 0.021
	$^{238}U_{leps}$[d]					2	0.56 ± 0.14	0.419 ± 0.33	0.71 ± 0.30
	$^{239}U_{iso}$[e]	2	0.16 ± 0.048	0.11 ± 0.024	0.21 ± 0.036				

(a) Reported mean error values ± standard error of the mean.
(b) Reported minimum error values ± total propagated analytical error.
(c) Reported maximum error values ± total propagated analytical error.
(d) Samples analyzed by low-energy photon system.
(e) Isotopic uranium.
(f) Fitzner/Eberhardt Arid Lands Ecology Reserve.

Table A.9. Radionuclide Activities (pCi/g dry wt.) in Soil Collected from the Fitzner-Eberhardt Arid Lands Ecology Reserve

Location[a]	Radionuclide	1993[b]	1998[b]
Rattlesnake Springs	Strontium-90	0.07 ± 0.02	0.08 ± 0.02
	Cesium-137	0.29 ± 0.04	0.21 ± 0.03
	Uranium-238[c]	0.51 ± 0.39	0.11 ± 0.02
	Plutonium-238	0.0002 ± 0.0001	0.0004 ± 0.0002
	Plutonium-239,240	0.007 ± 0.001	0.008 ± 0.001
Arid Lands Ecology Field Laboratory	Strontium-90	0.11 ± 0.02	0.012 ± 0.004
	Cesium-137	0.22 ± 0.04	0.02 ± 0.01
	Uranium-238[c]	1.01 ± 0.50	0.21 ± 0.04
	Plutonium-238	0.0002 ± 0.0002	ND[d]
	Plutonium-239,240	0.006 ± 0.001	0.0009 ± 0.0005

(a) See Figure 4.6.1.
(b) ± total propagated uncertainty (2 sigma).
(c) 1993 uranium-238 was determined by low-energy photon analysis; 1998 sample was determined by alpha spectrometry.
(d) ND = Not detected.

Table A.10. Activities of Selected Radionuclides (pCi/g dry wt.) in Vegetation, 1998 Compared to Previous 6 Years

	1998				1992-1997			
Radionuclide	No. Less Than Dectection	Mean[a]	Minimum[b]	Maximum[c]	No. Less Than Detection	Mean[a]	Minimum[b]	Maximum[c]
Onsite								
$^{239,240}Pu$	5 of 6	0.00007 ± 0.0006	0.00003 ± 0.0001	0.0039 ± 0.0008	7 of 14	0.0027 ± 0.0013	-0.00002 ± 0.0002	0.015 ± 0.0024
^{238}Pu	6 of 6	0.00003 ± 0.00002	-0.00003 ± 0.0001	0.0001 ± 0.0002	11 of 14	0.0072 ± 0.0045	-0.0006 ± 0.0007	0.051 ± 0.0062
^{137}Cs	6 of 6	0.001 ± 0.01	-0.02 ± 0.01	0.02 ± 0.01	6 of 14	0.29 ± 0.15	-0.003 ± 0.01	1.54 ± 0.17
^{90}Sr	2 of 7	0.02 ± 0.01	0.001 ± 0.005	0.037 ± 0.01	0 of 14	3.07 ± 2.65	0.01 ± 0.004	37.4 ± 9.19
$^{238}U_{NAT}$[d]					2 of 4	0.003 ± 0.01	-0.02 ± 0.02	0.02 ± 0.01
$^{239}U_{iso}$[e]	7 of 7	-0.002 ± 0.002	-0.007 ± 0.004	0.003 ± 0.001	7 of 10	0.002 ± 0.001	-0.0005 ± 0.005	0.01 ± 0.003
Perimeter								
$^{239,240}Pu$	2 of 4	0.0001 ± 0.0001	0.00004 ± 0.00008	0.0003 ± 0.0003	7 of 13	0.0002 ± 0.00003	-0.00001 ± 0.0003	0.0004 ± 0.0003
^{238}Pu	4 of 4	0.0001 ± 0.0001	0.00002 ± 0.0001	0.0001 ± 0.0001	13 of 13	0.00003 ± 0.0001	-0.0003 ± 0.0009	0.0006 ± 0.001
^{137}Cs	4 of 4	0.01 ± 0.006	0.004 ± 0.01	0.03 ± 0.02	12 of 13	0.003 ± 0.003	-0.03 ± 0.03	0.02 ± 0.02
^{90}Sr	0 of 4	0.02 ± 0.005	0.01 ± 0.01	0.04 ± 0.01	1 of 13	0.02 ± 0.006	0.002 ± 0.003	0.07 ± 0.02
$^{238}U_{NAT}$[d]					4 of 4	-0.003 ± 0.003	-0.01 ± 0.01	0.005 ± 0.01
$^{239}U_{iso}$[e]	4 of 4	0.006 ± 0.002	0.001 ± 0.006	0.016 ± 0.019	2 of 9	0.01 ± 0.003	0.0002 ± 0.002	0.03 ± 0.008
Distant								
$^{239,240}Pu$	2 of 2	0.00001 ± 0.00001	-0.00001 ± 0.00006	0.00002 ± 0.0001	4 of 5	0.0001 ± 0.00002	0.00004 ± 0.0001	0.0002 ± 0.0001
^{238}Pu	2 of 2	0.00002 ± 0.00003	-0.00001 ± 0.0001	0.00004 ± 0.0001	5 of 5	0.00001 ± 0.00001	-0.00001 ± 0.0001	0.0001 ± 0.0001
^{137}Cs	2 of 2	0.02 ± 0.01	0.01 ± 0.01	0.03 ± 0.01	4 of 5	0.01 ± 0.01	-0.02 ± 0.02	0.03 ± 0.03
^{90}Sr	0 of 2	0.03 ± 0.02	0.01 ± 0.01	0.04 ± 0.01	1 of 5	0.01 ± 0.003	0.003 ± 0.003	0.02 ± 0.005
$^{238}U_{NAT}$[d]					1 of 1			-0.002 ± 0.01
$^{239}U_{iso}$[e]	2 of 2	-0.004 ± 0.004	-0.01 ± 0.007	-0.0002 ± 0.006	1 of 4	0.004 ± 0.001	0.001 ± 0.002	0.005 ± 0.003

(a) Reported mean error values ± standard error of the mean.
(b) Reported minimum error values ± total propagated analytical error.
(c) Reported maximum error values ± total propagated analytical error.
(d) U_{NAT} is a chemical analysis not used in 1998.
(e) Isotopic uranium.

Table A.11. Metal Concentrations in Hanford Site Fruit Tree Samples, 1997 and 1998

Location	Medium	Concentration, μg/kg dry wt. Antimony ICP-MS[a]		Arsenic ICP-MS		Beryllium ICP-MS		Cadmium ICP-MS		Chromium ICP-MS		Copper ICP-MS	Lead ICP-MS	
1997														
100-D Area	Apricot leaves	0.015	U[b]	0.250		0.150	U	0.151		0.285		8.73	0.114	
100-D Area	Apricot leaves	0.015	U	0.170		0.150	U	0.206		0.314		8.75	0.194	
100-F Area	Apricot leaves	0.015	U	0.394		0.150	U	0.0971		0.200	U	4.25	0.145	
Old Hanford Townsite	Quince fruit	0.015	U	0.154		0.150	U	0.0528		0.200	U	4.78	0.111	
Old Hanford Townsite	Quince leaves	0.015	U	0.0327		0.150	U	0.0794		0.200	U	3.38	0.036	U
1997 Detection Limits		0.015		0.030		0.150		0.020		0.200		0.020	0.036	
1998														
Old Hanford Townsite	Apple fruit	0.020	U	0.15	U	0.010	U	0.055		1.0	U	2.59	0.0298	
Old Hanford Townsite	Apple leaves	0.020	U	0.248		0.010	U	0.04	U	1.0	U	6.70	0.251	
100-F Area	Apricot fruit	0.020	U	0.214		0.010	U	0.04	U	1.0	U	14.1	0.0343	
100-F Area	Apricot leaves	0.020	U	0.333		0.010	U	0.04	U	1.0	U	5.50	0.119	
1998 Detection Limits		0.020		0.15		0.010		0.04		1.0		0.8	0.01	

Location	Medium	Concentration, μg/kg dry wt. Mercury CVAA[c]	Nickel ICP-MS		Selenium ICP-MS		Silver ICP-MS		Thallium ICP-MS		Zinc ICP-MS
1997											
100-D Area	Apricot leaves	0.0203	0.842		1.00	U	0.045	U	0.005	U	12.9
100-D Area	Apricot leaves	0.0210	1.08		1.00	U	0.045	U	0.0188		16.7
100-F Area	Apricot leaves	0.0174	0.790		1.00	U	0.045	U	0.005	U	9.81
Old Hanford Townsite	Quince fruit	0.0221	0.946		1.00	U	0.045	U	0.005	U	5.86
Old Hanford Townsite	Quince leaves	0.00180	0.125		1.00	U	0.045	U	0.00640		3.08
1997 Detection Limits		0.001	0.020		1.00		0.045		0.005		0.150
1998											
Old Hanford Townsite	Apple fruit	0.0016	U	0.15	U	2.0	U	0.01	U	0.01	U	2.00
Old Hanford Townsite	Apple leaves	0.0210	0.931		2.0	U	0.0243		0.01	U	12.2
100-F Area	Apricot fruit	0.0016	U	0.634	2.0	U	0.0164		0.01	U	16.7
100-F Area	Apricot leaves	0.0016	U	0.469	2.0	U	0.01	U	0.01	U	16.7
1998 Detection Limits		0.0016	0.15		2.00		0.010		0.01		1.00

(a) ICP-MS = Inductively coupled plasma-mass spectrometry.
(b) U = Undetected.
(c) CVAA = Cold vapor atomic absorption.

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