



## **APPENDIX B**

# **ADDITIONAL MONITORING RESULTS**

## **FOR 2002**

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This appendix contains additional information on 2002 monitoring results, supplementing the data summarized in

the main body of the report. More detailed information is available in PNNL-14295, APP. 1.

**Table B.1. Radionuclide Concentrations in Columbia River Water Samples Collected at Priest Rapids Dam, Washington, 2002 Compared to Previous 5 Years**

Radionuclide <sup>(a)</sup>	No. of Samples	2002		No. of Samples	1997-2001		Ambient Surface Water Quality Standard, pCi/L
		Maximum	Average		Maximum	Average	
<b>Composite System</b>							
Tritium	12	54 ± 8.0	35 ± 26	57	200 ± 22	38 ± 25	20,000 <sup>(c)</sup>
Alpha (gross)	12	0.98 ± 0.88 <sup>(d)</sup>	0.29 ± 0.65 <sup>(d)</sup>	59	5.6 ± 3.1	0.56 ± 1.5	15 <sup>(e,f)</sup>
Beta (gross)	12	3.2 ± 1.8	1.1 ± 1.8	59	7.7 ± 2.2	0.80 ± 3.4	50 <sup>(e,f)</sup>
Strontium-90	12	0.10 ± 0.043	0.067 ± 0.031	59	0.13 ± 0.062	0.076 ± 0.036	8 <sup>(e,f)</sup>
Technetium-99	12	0.53 ± 0.55 <sup>(d)</sup>	0.055 ± 0.52 <sup>(d)</sup>	59	1.6 ± 0.69	0.031 ± 0.50	900 <sup>(c)</sup>
Iodine-129	4	0.000021 ± 0.0000028	0.000012 ± 0.0000018	19	0.000022 ± 0.0000021	0.0000082 ± 0.0000012	1 <sup>(c)</sup>
Uranium-234	12	0.24 ± 0.059	0.21 ± 0.037	59	0.42 ± 0.087	0.24 ± 0.097	-- <sup>(g)</sup>
Uranium-235	12	0.014 ± 0.011	0.0045 ± 0.010	59	0.025 ± 0.016	0.0068 ± 0.013	--
Uranium-238	12	0.24 ± 0.062	0.19 ± 0.060	59	0.38 ± 0.080	0.20 ± 0.094	--
Uranium (total)	12	0.46 ± 0.083	0.40 ± 0.076	59	0.81 ± 0.12	0.45 ± 0.19	--
<b>Continuous System</b>							
Cobalt-60	P	12	0.00092 ± 0.00071 <sup>(d)</sup>	0.00044 ± 0.0011 <sup>(d)</sup>	44	0.0013 ± 0.0016 <sup>(d)</sup>	0.00022 ± 0.00096 <sup>(d)</sup>
	D	12	0.0033 ± 0.0021 <sup>(d)</sup>	0.0014 ± 0.0027 <sup>(d)</sup>	44	0.0051 ± 0.0053 <sup>(d)</sup>	0.00078 ± 0.0032 <sup>(d)</sup>
Cesium-137	P	12	0.00096 ± 0.00071 <sup>(d)</sup>	0.00032 ± 0.00078 <sup>(d)</sup>	44	0.0032 ± 0.0013	0.00086 ± 0.0016
	D	12	0.0025 ± 0.0025 <sup>(d)</sup>	0.0013 ± 0.0016 <sup>(d)</sup>	44	0.0034 ± 0.0021 <sup>(d)</sup>	0.00098 ± 0.0022 <sup>(d)</sup>
Europium-155	P	12	0.0018 ± 0.0017 <sup>(d)</sup>	0.00024 ± 0.0017 <sup>(d)</sup>	44	0.0032 ± 0.0044 <sup>(d)</sup>	0.00023 ± 0.0022 <sup>(d)</sup>
	D	12	0.0079 ± 0.0041 <sup>(d)</sup>	0.0024 ± 0.0046 <sup>(d)</sup>	44	0.012 ± 0.014 <sup>(d)</sup>	0.0013 ± 0.0061 <sup>(d)</sup>
Plutonium-239/240	P	4	0.000040 ± 0.000022	0.000022 ± 0.000024	20	0.00028 ± 0.00010	0.000058 ± 0.00014
	D	4	0.000039 ± 0.000058 <sup>(d)</sup>	0.000019 ± 0.000035 <sup>(d)</sup>	20	0.000056 ± 0.00010 <sup>(d)</sup>	0.000022 ± 0.000043

- (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).
- (b) Maximum values are ± total propagated analytical uncertainty (2 sigma). Averages are ±2 standard error of the calculated mean. To convert to international metric system units, multiply pCi/L by 0.037 to obtain Bq/L.
- (c) WAC 173-201A-050 and EPA-570/9-76-003.
- (d) Less than the detection limit.
- (e) WAC 246-290.
- (f) 40 CFR 141.
- (g) Dashes indicate no concentration guides available.

**Table B.2. Radionuclide Concentrations in Columbia River Water at the Richland Pumphouse in Richland, Washington, 2002 Compared to Previous 5 Years**

<u><b>Radionuclide<sup>(a)</sup></b></u>	<u>No. of Samples</u>	<u>2002</u>		<u>1997-2001</u>		<u>Ambient Surface Water Quality Standard, pCi/L</u>
		<u>Maximum</u>	<u>Average</u>	<u>Maximum</u>	<u>Average</u>	
<b>Composite System</b>						
Tritium	12	110 ± 13	61 ± 49	57	150 ± 18	73 ± 48
Alpha (gross)	12	1.0 ± 0.82 <sup>(d)</sup>	0.55 ± 0.69	59	2.2 ± 1.1	0.60 ± 0.85
Beta (gross)	12	1.4 ± 1.5 <sup>(d)</sup>	0.54 ± 1.3 <sup>(d)</sup>	59	6.6 ± 2.5	0.78 ± 2.8
Strontium-90	12	0.080 ± 0.033	0.058 ± 0.026	59	0.13 ± 0.048	0.072 ± 0.040
Technetium-99	12	0.46 ± 0.55 <sup>(d)</sup>	0.0046 ± 0.51 <sup>(d)</sup>	59	0.53 ± 0.52	0.045 ± 0.28
Iodine-129	4	0.000088 ± 0.000014	0.000066 ± 0.000057	19	0.00019 ± 0.000022	0.00010 ± 0.000082
Uranium-234	12	0.32 ± 0.073	0.25 ± 0.064	59	0.40 ± 0.071	0.27 ± 0.096
Uranium-235	12	0.012 ± 0.014 <sup>(d)</sup>	0.0051 ± 0.0074	59	0.024 ± 0.015	0.0091 ± 0.012
Uranium-238	12	0.29 ± 0.067	0.22 ± 0.073	59	0.30 ± 0.066	0.22 ± 0.077
Uranium (total)	12	0.62 ± 0.29	0.47 ± 0.14	59	0.70 ± 0.091	0.50 ± 0.16
<b>Continuous System</b>						
Cobalt-60	P	12	0.00095 ± 0.00078 <sup>(d)</sup>	0.000082 ± 0.0010 <sup>(d)</sup>	44	0.0016 ± 0.0011 <sup>(d)</sup>
	D	12	0.0027 ± 0.0020 <sup>(d)</sup>	0.00081 ± 0.0016 <sup>(d)</sup>	44	0.0034 ± 0.0044 <sup>(d)</sup>
Cesium-137	P	12	0.0012 ± 0.00075 <sup>(d)</sup>	0.00043 ± 0.00091 <sup>(d)</sup>	44	0.0037 ± 0.0015
	D	12	0.0018 ± 0.0018 <sup>(d)</sup>	0.00052 ± 0.0019 <sup>(d)</sup>	44	0.0071 ± 0.0052 <sup>(d)</sup>
Europium-155	P	12	0.0023 ± 0.0020 <sup>(d)</sup>	0.00050 ± 0.0019 <sup>(d)</sup>	44	0.0022 ± 0.0017 <sup>(d)</sup>
	D	12	0.0042 ± 0.0045 <sup>(d)</sup>	-0.000016 ± 0.0058 <sup>(d)</sup>	44	0.0077 ± 0.013 <sup>(d)</sup>
Plutonium-239/240	P	4	0.000023 ± 0.000016	0.000011 ± 0.000015	20	0.00017 ± 0.000087
	D	4	0.000014 ± 0.000028 <sup>(d)</sup>	-0.00000029 ± 0.000034 <sup>(d)</sup>	20	0.00016 ± 0.000091

- (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).
- (b) Maximum values are ± total propagated analytical uncertainty (2 sigma). Averages are ±2 standard error of the calculated mean. To convert to international metric system units, multiply pCi/L by 0.037 to obtain Bq/L.
- (c) WAC 173-201A-050 and EPA-570/9-76-003.
- (d) Less than the detection limit.
- (e) WAC 246-290.
- (f) 40 CFR 141.
- (g) Dashes indicate no concentration guides available.

**Table B.3. Radionuclide Concentrations Measured in Columbia River Water Samples Collected Along Transects of the Hanford Reach, 2002**

<b>Transect/Radionuclide</b>	<b>No. of Samples</b>	<b>Concentration,<sup>(a)</sup> pCi/L</b>		
		<b>Maximum</b>	<b>Minimum</b>	<b>Mean</b>
<b>Vernita Bridge (HRM 0.3)<sup>(b)</sup></b>				
Tritium	16	54 ± 8.0	20 ± 3.4	36 ± 20
Strontium-90	16	0.16 ± 0.051	0.043 ± 0.035 <sup>(c)</sup>	0.071 ± 0.056
Uranium (total)	16	0.54 ± 0.089	0.33 ± 0.061	0.41 ± 0.12
<b>100-N Area (HRM 9.5)</b>				
Tritium	7	38 ± 4.5	18 ± 3.3	25 ± 15
Strontium-90	7	0.095 ± 0.036	0.049 ± 0.035 <sup>(c)</sup>	0.067 ± 0.034
Uranium (total)	7	0.44 ± 0.075	0.35 ± 0.066	0.37 ± 0.061
<b>100-F Area (HRM 19)</b>				
Tritium	6	30 ± 4.3	21 ± 3.5	23 ± 6.8
Strontium-90	6	0.059 ± 0.026	0.040 ± 0.021	0.048 ± 0.013
Uranium (total)	6	0.45 ± 0.088	0.33 ± 0.063	0.37 ± 0.084
<b>Hanford Town Site (HRM 28.7)</b>				
Tritium	6	3,100 ± 160	20 ± 3.8	610 ± 2,500
Strontium-90	6	0.090 ± 0.041	0.057 ± 0.037	0.072 ± 0.028
Uranium (total)	6	0.49 ± 0.084	0.37 ± 0.067	0.41 ± 0.091
<b>300 Area (HRM 43.1)</b>				
Tritium	6	48 ± 5.2	32 ± 4.2	40 ± 11
Strontium-90	6	0.076 ± 0.035	0.042 ± 0.030 <sup>(c)</sup>	0.063 ± 0.022
Uranium (total)	6	0.75 ± 0.12	0.36 ± 0.065	0.46 ± 0.30
<b>Richland Pumphouse (HRM 46.4)</b>				
Tritium	26	190 ± 19	18 ± 3.3	52 ± 94
Strontium-90	26	0.097 ± 0.039	0.037 ± 0.027 <sup>(c)</sup>	0.067 ± 0.024
Uranium (total)	26	1.5 ± 0.21	0.32 ± 0.060	0.51 ± 0.48

(a) Maximum and minimum values are ± total propagated analytical uncertainty (2-sigma). Mean values are ±2 standard error of the mean. To convert to international metric system units, multiply pCi/L by 0.037 to obtain Bq/L.

(b) HRM = Hanford River Mile (e.g., Vernita Bridge crossing is Mile 0, the Richland Pumphouse is Mile 46.4).

(c) Below detection limit.

**Table B.4. Radionuclide Concentrations Measured in Columbia River Water Samples Collected at Near-Shore Locations in the Hanford Reach, 2002**

<u>Near-Shore/Radionuclide</u>	<u>No. of Samples</u>	<u>Concentration,<sup>(a)</sup> pCi/L</u>		
		<u>Maximum</u>	<u>Minimum</u>	<u>Mean</u>
<b>Vernita Bridge (HRM 0.3)<sup>(b)</sup></b>				
Tritium	4	50 ± 7.7	33 ± 4.2	39 ± 15
Strontium-90	4	0.092 ± 0.076 <sup>(c)</sup>	0.050 ± 0.029	0.072 ± 0.039
Uranium (total)	4	0.49 ± 0.084	0.33 ± 0.061	0.41 ± 0.13
<b>100-N Area (HRM 8.4 to 9.8)</b>				
Tritium	6	38 ± 4.5	24 ± 3.8	29 ± 11
Strontium-90	6	0.22 ± 0.066	0.045 ± 0.028	0.11 ± 0.14
Uranium (total)	6	0.38 ± 0.067	0.34 ± 0.062	0.36 ± 0.026
<b>100-F Area (HRM 18-23)</b>				
Tritium	4	27 ± 3.8	21 ± 3.5	24 ± 4.5
Strontium-90	4	0.054 ± 0.025	0.020 ± 0.017 <sup>(c)</sup>	0.039 ± 0.029
Uranium (total)	4	0.38 ± 0.073	0.33 ± 0.063	0.35 ± 0.040
<b>Hanford Town Site (HRM 26 to 30)</b>				
Tritium	5	16,000 ± 490	22 ± 4.4	4,100 ± 13,000
Strontium-90	5	0.090 ± 0.041	0.056 ± 0.029	0.072 ± 0.028
Uranium (total)	5	1.1 ± 0.16	0.37 ± 0.067	0.55 ± 0.60
<b>300 Area (HRM 41.5 to 43.1)</b>				
Tritium	5	70 ± 6.9	34 ± 4.3	51 ± 31
Strontium-90	5	0.094 ± 0.040	0.066 ± 0.038	0.078 ± 0.020
Uranium (total)	5	0.42 ± 0.073	0.36 ± 0.065	0.38 ± 0.052
<b>Richland Pumphouse (HRM 43.5 to 46.4)</b>				
Tritium	22	190 ± 19	21 ± 3.4	78 ± 140
Strontium-90	22	0.096 ± 0.043	0.045 ± 0.029	0.070 ± 0.027
Uranium (total)	22	0.94 ± 0.14	0.34 ± 0.063	0.51 ± 0.42

(a) Maximum and minimum values are ± total propagated analytical uncertainty (2-sigma). Mean values are ±2 standard deviations. To convert to international metric system units, multiply pCi/L by 0.037 to obtain Bq/L.

(b) HRM = Hanford River Mile (e.g., Vernita Bridge crossing is Mile 0, the Richland Pumphouse is Mile 46.4).

(c) Below detection limit.

**Table B.5. Selected U.S. Geological Survey Columbia River Water Quality Data for Vernita and Richland, Washington,<sup>(a)</sup> 2002**

<b>Analysis</b>	<b>Units</b>	<b>Vernita Bridge (upstream)</b>			<b>Richland Pumphouse (downstream)</b>			<b>Washington Ambient Surface Water Quality Standard<sup>(b)</sup></b>		
		<b>No. of Samples</b>	<b>Median</b>	<b>Maximum</b>	<b>Minimum</b>	<b>No. of Samples</b>	<b>Median</b>	<b>Maximum</b>	<b>Minimum</b>	
Temperature	°C	4	12	19	4.0	4	12	18	4.0	20 (maximum)
Dissolved oxygen	mg/L	4	11	13	9.2	4	11	14	8.7	8 (minimum)
Turbidity	NTU <sup>(c)</sup>	4	1.6	3.0	<1.0	4	2.4	3.7	2.0	5 + background
pH	pH units	4	7.7	8.2	7.6	4	7.6	8.3	7.4	6.5 - 8.5
Sulfate, dissolved	mg/L	4	8.3	10	5.9	4	8.4	10	6.1	-- <sup>(d)</sup>
Dissolved solids, 180°C (356°F)	mg/L	4	78	90	58	4	76	83	60	--
Specific conductance	µS/cm	4	130	150	110	4	130	150	110	--
Total hardness, as CaCO <sub>3</sub>	mg/L	4	60	65	47	4	60	68	48	--
Alkalinity	mg/L	4	53	64	50	4	55	64	50	
Phosphorus, total	mg/L	4	<0.6	<0.6	<0.4	4	<0.06	<0.06	<0.04	--
Chromium, dissolved	µg/L	4	<0.8	<0.8	<0.8	4	<0.8	<0.8	0.5 <sup>(e)</sup>	--
Dissolved organic carbon	mg/L	4	1.4	2.0	1.2	4	1.4	2.1	1.2	--
Iron, dissolved	µg/L	4	<10	10	<10	4	<10	31	7.0 <sup>(e)</sup>	--
Ammonia, dissolved, as N	mg/L	4	<0.04	<0.04	<0.04	4	<0.04	<0.04	<0.04	--
Nitrite + nitrate, dissolved, as N	mg/L	4	0.085	0.14	0.04 <sup>(e)</sup>	4	0.11	0.17	0.06	--

(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.

(e) Estimated value.

**Table B.6. Concentrations (µg/L) of Dissolved Metals in Columbia River Transect and Near-Shore Water Samples Collected Near the Hanford Site, 2002**

<b>Location</b>	<b>Metal</b>	<b>No. of Samples</b>	<b>Maximum</b>	<b>Minimum</b>	<b>Average</b>	<b>±2SD<sup>(a)</sup></b>
Vernita Bridge	Antimony	12	0.26	0.12	0.19	0.093
	Arsenic	12	0.78	0.48	0.58	0.21
	Beryllium	12	0.055	0.008 <sup>(b)</sup>	0.024	0.032
	Cadmium	12	0.058	0.011 <sup>(b)</sup>	0.026	0.033
	Chromium	12	0.26	0.037	0.12	0.16
	Copper	12	1.0	0.40	0.57	0.37
	Lead	12	0.32	0.011 <sup>(b)</sup>	0.048	0.17
	Mercury	4	0.00036	0.00029	0.00033	0.000066
	Nickel	12	0.77	0.17	0.49	0.47
	Selenium	12	0.50 <sup>(b)</sup>	0.11 <sup>(b)</sup>	0.40	0.31
	Silver	12	0.013	0.0012 <sup>(b)</sup>	0.0046	0.0063
	Thallium	12	0.026	0.010	0.018	0.011
	Zinc	12	4.4	0.82	1.6	2.1
100-N Area	Antimony	10	0.22	0.17	0.18	0.028
	Arsenic	10	0.64	0.61	0.62	0.023
	Beryllium	10	0.024 <sup>(b)</sup>	0.024 <sup>(b)</sup>	0.024 <sup>(b)</sup>	0
	Cadmium	10	0.027	0.011	0.018	0.011
	Chromium	10	0.13	0.066	0.096	0.044
	Copper	10	0.69	0.56	0.62	0.074
	Lead	10	0.019	0.011 <sup>(b)</sup>	0.013	0.0053
	Mercury	0	--	--	--	--
	Nickel	10	0.25	0.15	0.21	0.066
	Selenium	10	0.50 <sup>(b)</sup>	0.50 <sup>(b)</sup>	0.50 <sup>(b)</sup>	0
	Silver	10	0.005 <sup>(b)</sup>	0.005 <sup>(b)</sup>	0.005 <sup>(b)</sup>	0
	Thallium	10	0.020	0.016	0.018	0.0023
	Zinc	10	3.7	0.80	1.3	1.7
100-F Area	Antimony	9	0.15	0.14	0.15	0.010
	Arsenic	9	0.60	0.50	0.53	0.066
	Beryllium	9	0.024 <sup>(b)</sup>	0.024 <sup>(b)</sup>	0.024 <sup>(b)</sup>	0
	Cadmium	9	0.014	0.011 <sup>(b)</sup>	0.012	0.0025
	Chromium	9	0.12	0.057	0.078	0.041
	Copper	9	0.43	0.39	0.42	0.026
	Lead	9	0.025	0.011	0.017	0.011
	Mercury	0	--	--	--	--
	Nickel	9	0.22	0.15	0.20	0.051
	Selenium	9	0.50 <sup>(b)</sup>	0.50 <sup>(b)</sup>	0.50 <sup>(b)</sup>	0
	Silver	9	0.005 <sup>(b)</sup>	0.005 <sup>(b)</sup>	0.005 <sup>(b)</sup>	0
	Thallium	9	0.017	0.013	0.015	0.0028
	Zinc	9	1.2	0.81	0.98	0.28
Hanford town site	Antimony	10	0.21	0.16	0.18	0.029
	Arsenic	10	1.6	0.57	0.76	0.63
	Beryllium	10	0.024 <sup>(b)</sup>	0.024 <sup>(b)</sup>	0.024 <sup>(b)</sup>	0
	Cadmium	10	0.029	0.013	0.019	0.0097
	Chromium	10	1.0	0.058	0.21	0.57
	Copper	10	0.88	0.54	0.64	0.18
	Lead	10	0.046	0.014	0.028	0.021
	Mercury	0	--	--	--	--
	Nickel	10	0.26	0.16	0.20	0.061
	Selenium	10	0.54	0.50 <sup>(b)</sup>	0.50	0.028
	Silver	10	0.005 <sup>(b)</sup>	0.005 <sup>(b)</sup>	0.005 <sup>(b)</sup>	0
	Thallium	10	0.021	0.016	0.019	0.0028
	Zinc	10	2.4	0.85	1.2	0.84

**Table B.6. (contd)**

<b>Location</b>	<b>Metal</b>	<b>No. of Samples</b>	<b>Maximum</b>	<b>Minimum</b>	<b>Average</b>	<b><math>\pm 2SD^{(a)}</math></b>
300 Area	Antimony	10	0.17	0.13	0.15	0.020
	Arsenic	10	0.75	0.46	0.55	0.15
	Beryllium	10	0.024 <sup>(b)</sup>	0.024 <sup>(b)</sup>	0.024 <sup>(b)</sup>	0
	Cadmium	10	0.017	0.011 <sup>(b)</sup>	0.012	0.0037
	Chromium	10	0.17	0.098	0.14	0.047
	Copper	10	2.3	0.36	0.61	1.2
	Lead	10	0.049	0.011	0.022	0.023
	Mercury	0	--	--	--	--
	Nickel	10	0.27	0.14	0.20	0.096
	Selenium	10	0.50 <sup>(b)</sup>	0.50 <sup>(b)</sup>	0.50 <sup>(b)</sup>	0
	Silver	10	0.005 <sup>(b)</sup>	0.005 <sup>(b)</sup>	0.005 <sup>(b)</sup>	0
	Thallium	10	0.018	0.014	0.016	0.0023
Richland Pumphouse	Zinc	10	1.5	0.74	1.0	0.49
	Antimony	30	0.29	0.14	0.20	0.092
	Arsenic	30	0.75	0.40	0.59	0.17
	Beryllium	30	0.067	0.008 <sup>(b)</sup>	0.0024	0.033
	Cadmium	30	0.058	0.011	0.026	0.034
	Chromium	30	0.24	0.016	0.10	0.15
	Copper	30	0.91	0.39	0.56	0.33
	Lead	30	0.041	0.015	0.026	0.016
	Mercury	6	0.00047	0.00035	0.00040	0.000085
	Nickel	30	0.84	0.16	0.50	0.44
	Selenium	30	0.50	0.11 <sup>(b)</sup>	0.42	0.29
	Silver	30	0.0093	0.0012 <sup>(b)</sup>	0.0047	0.0056
	Thallium	30	0.026	0.0095	0.017	0.0077
	Zinc	30	2.7	0.78	1.5	1.3

(a) SD = Standard deviation.

(b) Below detection limit.

**Table B.7. Radionuclide Concentrations in Sediment from the Columbia River Near the Hanford Site and from Columbia River Riverbank Springs Along the Hanford Site, 2002 Compared to Previous 5 Years**

<u>Location</u>	<u>Radionuclide</u>	No. of Samples	2002		No. of Samples	1997-2001	
			Median <sup>(b)</sup>	Concentration, pCi/g <sup>(a)</sup> Maximum <sup>(c)</sup>		Median <sup>(b)</sup>	Concentration, pCi/g <sup>(a)</sup> Maximum <sup>(c)</sup>
<b>River Sediment (2002 TOC Value)<sup>(d)</sup></b>							
100-F Slough (175 mg/kg)	Cobalt-60	1		0.0079 ± 0.019 <sup>(e)</sup>	5	0.016 <sup>(e)</sup>	0.024 ± 0.013 <sup>(e)</sup>
	Cesium-137	1		0.30 ± 0.041	5	0.28	0.36 ± 0.042
	Europium-155	1		0.046 ± 0.027 <sup>(e)</sup>	5	0.040 <sup>(e)</sup>	0.069 ± 0.062 <sup>(e)</sup>
	Plutonium-239/240	1		0.0014 ± 0.00039	5	0.0020	0.0023 ± 0.00054
	Strontium-90	1		0.0054 ± 0.013 <sup>(e)</sup>	5	0.0017	0.0052 ± 0.0037
	Uranium-234	1		0.17 ± 0.037	4	0.15	0.31 ± 0.062
	Uranium-235	1		0.011 ± 0.0058	5	0.0058	0.064 ± 0.068 <sup>(e)</sup>
	Uranium-238	1		0.17 ± 0.036	5	0.15	0.99 ± 0.33
◆ B.9 ◆	Hanford Slough (3,310 mg/kg)	Cobalt-60	1	0.0099 ± 0.014 <sup>(e)</sup>	5	0.011	0.18 ± 0.028
	Cesium-137	1		0.0071 ± 0.013 <sup>(e)</sup>	5	0.13	0.25 ± 0.036
	Europium-155	1		0.011 ± 0.043 <sup>(e)</sup>	5	0.059 <sup>(e)</sup>	0.068 ± 0.029 <sup>(e)</sup>
	Plutonium-239/240	1		0.0045 ± 0.00093	5	0.0014	0.0037 ± 0.00083
	Strontium-90	1		0.0059 ± 0.019 <sup>(e)</sup>	5	0.0036	0.010 ± 0.0052
	Uranium-234	1		0.53 ± 0.10	4	0.24	0.37 ± 0.072
	Uranium-235	1		0.017 ± 0.0077	5	0.0090	0.040 ± 0.077 <sup>(e)</sup>
	Uranium-238	1		0.47 ± 0.092	5	0.27	1.4 ± 0.43
McNary Dam (6,270 - 8,630 mg/kg)	Cobalt-60	2	0.015 <sup>(e)</sup>	0.016 ± 0.018 <sup>(e)</sup>	24	0.030	0.12 ± 0.042 <sup>(e)</sup>
	Cesium-137	2	0.24	0.25 ± 0.039	24	0.36	1.1 ± 0.15
	Europium-155	2	0.067 <sup>(e)</sup>	0.079 ± 0.047 <sup>(e)</sup>	24	0.056 <sup>(e)</sup>	0.13 ± 0.066 <sup>(e)</sup>
	Plutonium-239/240	2	0.0081	0.0089 ± 0.0017	24	0.0078	0.032 ± 0.0048
	Strontium-90	2	0.025 <sup>(e)</sup>	0.027 ± 0.023 <sup>(e)</sup>	24	0.020	0.043 ± 0.028
	Uranium-234	2	0.82	0.85 ± 0.16	20	0.73	0.87 ± 0.17
	Uranium-235	2	0.024	0.030 ± 0.012	24	0.024	0.21 ± 0.10 <sup>(e)</sup>
	Uranium-238	2	0.70	0.70 ± 0.13	24	0.62	1.9 ± 0.49
Priest Rapids Dam (5,630 - 7,660 mg/kg)	Cobalt-60	2	0.000010 <sup>(e)</sup>	0.0068 ± 0.015 <sup>(e)</sup>	19	0.0080 <sup>(e)</sup>	0.042 ± 0.041 <sup>(e)</sup>
	Cesium-137	2	0.53	0.65 ± 0.086	19	0.34	0.60 ± 0.11
	Europium-155	2	0.040 <sup>(e)</sup>	0.066 ± 0.041 <sup>(e)</sup>	19	0.046 <sup>(e)</sup>	0.082 ± 0.088 <sup>(e)</sup>
	Plutonium-239/240	2	0.012	0.015 ± 0.0024	19	0.0087	0.017 ± 0.0030
	Strontium-90	2	-0.0049 <sup>(e)</sup>	-0.0023 ± 0.020 <sup>(e)</sup>	19	0.013	0.028 ± 0.028 <sup>(e)</sup>
	Uranium-234	2	0.62	0.72 ± 0.14	16	0.51	0.83 ± 0.14
	Uranium-235	2	0.023	0.024 ± 0.0094	19	0.018	0.14 ± 0.086 <sup>(e)</sup>
	Uranium-238	2	0.54	0.62 ± 0.12	19	0.56	1.4 ± 0.50

**Table B.7. (contd)**

<u>Location</u>	<u>Radionuclide</u>	2002			1997-2001		
		No. of Samples	Concentration, pCi/g <sup>(a)</sup> Median <sup>(b)</sup>	Maximum <sup>(c)</sup>	No. of Samples	Concentration, pCi/g <sup>(a)</sup> Median <sup>(b)</sup>	Maximum <sup>(c)</sup>
Richland (919 mg/kg)	Cobalt-60	1		-0.0035 ± 0.011 <sup>(e)</sup>	5	0.020 <sup>(e)</sup>	0.035 ± 0.012 <sup>(e)</sup>
	Cesium-137	1		0.12 ± 0.024	5	0.23	0.24 ± 0.049
	Europium-155	1		0.046 ± 0.030 <sup>(e)</sup>	5	0.035 <sup>(e)</sup>	0.062 ± 0.030 <sup>(e)</sup>
	Plutonium-239/240	1		0.0014 ± 0.00038	5	0.0016	0.0034 ± 0.00073
	Strontium-90	1		-0.025 ± 0.025 <sup>(e)</sup>	5	0.0041	0.0063 ± 0.0041
	Uranium-234	1		0.12 ± 0.030	4	0.21	0.25 ± 0.053
	Uranium-235	1		0.0047 ± 0.0046	5	0.011	0.053 ± 0.074 <sup>(e)</sup>
	Uranium-238	1		0.13 ± 0.032	5	0.24	0.83 ± 0.28 <sup>(e)</sup>
White Bluffs Slough (14,800 mg/kg)	Cobalt-60	1		0.060 ± 0.025 <sup>(e)</sup>	5	0.051	0.11 ± 0.024
	Cesium-137	1		0.64 ± 0.089	5	0.53	0.60 ± 0.067
	Europium-155	1		0.025 ± 0.058 <sup>(e)</sup>	5	0.052 <sup>(e)</sup>	0.10 ± 0.034 <sup>(e)</sup>
	Plutonium-239/240	1		0.0077 ± 0.0017	5	0.0044	0.0058 ± 0.0011
	Strontium-90	1		0.0028 ± 0.029 <sup>(e)</sup>	5	0.0023	0.0082 ± 0.0049
	Uranium-234	1		1.6 ± 0.30	4	0.39	0.69 ± 0.13
	Uranium-235	1		0.053 ± 0.016	5	0.0087	0.027 ± 0.010
	Uranium-238	1		1.3 ± 0.24	5	0.38	1.0 ± 0.36
<b>Riverbank Spring Sediment</b>							
100-B Spring	Cobalt-60	1		0.0031 ± 0.011 <sup>(e)</sup>	5	0.021 <sup>(e)</sup>	0.051 ± 0.024 <sup>(e)</sup>
	Cesium-137	1		0.059 ± 0.016	5	0.079	0.14 ± 0.026
	Europium-155	1		0.078 ± 0.030 <sup>(e)</sup>	5	0.077 <sup>(e)</sup>	0.11 ± 0.072 <sup>(e)</sup>
	Strontium-90	1		-0.0036 ± 0.021 <sup>(e)</sup>	5	0.0020 <sup>(e)</sup>	0.0041 ± 0.0083 <sup>(e)</sup>
	Uranium-234	1		0.19 ± 0.042	4	0.37	0.49 ± 0.087
	Uranium-235	1		0.0098 ± 0.0059	5	0.015	0.20 ± 0.10 <sup>(e)</sup>
	Uranium-238	1		0.20 ± 0.042	5	0.40	1.2 ± 0.40 <sup>(e)</sup>
100-F Spring	Cobalt-60	1		0.0057 ± 0.011 <sup>(e)</sup>	5	0.018 <sup>(e)</sup>	0.044 ± 0.024 <sup>(e)</sup>
	Cesium-137	1		0.071 ± 0.019	5	0.14	0.20 ± 0.035
	Europium-155	1		0.058 ± 0.034 <sup>(e)</sup>	5	0.030 <sup>(e)</sup>	0.070 ± 0.031 <sup>(e)</sup>
	Strontium-90	1		-0.0080 ± 0.027 <sup>(e)</sup>	5	0.0041	0.013 ± 0.032 <sup>(e)</sup>
	Uranium-234	1		0.52 ± 0.10	5	0.49	0.70 ± 0.14
	Uranium-235	1		0.024 ± 0.0097	6	0.036	0.083 ± 0.11 <sup>(e)</sup>
	Uranium-238	1		0.42 ± 0.083	6	0.54	0.97 ± 0.43 <sup>(e)</sup>

**Table B.7. (contd)**

<b>Location</b>	<b>Radionuclide</b>	2002			1997-2001		
		No. of Samples	Concentration, pCi/g <sup>(a)</sup> Median <sup>(b)</sup>	Maximum <sup>(c)</sup>	No. of Samples	Concentration, pCi/g <sup>(a)</sup> Median <sup>(b)</sup>	Maximum <sup>(c)</sup>
100-K Spring	Cobalt-60	1		0.0053 ± 0.013 <sup>(e)</sup>	1		0.015 ± 0.021 <sup>(e)</sup>
	Cesium-137	1		0.10 ± 0.023	1		0.19 ± 0.046
	Europium-155	1		0.057 ± 0.041 <sup>(e)</sup>	1		0.039 ± 0.047 <sup>(e)</sup>
	Strontium-90	1		0.015 ± 0.024 <sup>(e)</sup>	1		0.0085 ± 0.0048
	Uranium-234	1		0.30 ± 0.065	0		--
	Uranium-235	1		0.0085 ± 0.0066	1		0.14 ± 0.065 <sup>(e)</sup>
	Uranium-238	1		0.28 ± 0.060	1		0.82 ± 0.24 <sup>(e)</sup>
300 Area Spring	Cobalt-60	2	0.0092 <sup>(e)</sup>	0.013 ± 0.012 <sup>(e)</sup>	6	0.012 <sup>(e)</sup>	0.020 ± 0.010 <sup>(e)</sup>
	Cesium-137	2	0.15	0.25 ± 0.038	6	0.066	0.27 ± 0.035
	Europium-155	2	0.070	0.085 ± 0.037 <sup>(e)</sup>	6	0.038 <sup>(e)</sup>	0.086 ± 0.035 <sup>(e)</sup>
	Uranium-234	2	6.1	11 ± 2.0	11	1.5	3.9 ± 0.6
	Uranium-235	2	0.20	0.38 ± 0.075	12	0.072	0.19 ± 0.11 <sup>(e)</sup>
	Uranium-238	2	5.4	10 ± 1.8	12	1.8	3.7 ± 0.57
Hanford Spring	Cobalt-60	1		0.032 ± 0.012 <sup>(e)</sup>	5	0.049	0.067 ± 0.026
	Cesium-137	1		0.099 ± 0.024	5	0.22	0.25 ± 0.058
	Europium-155	1		0.10 ± 0.035 <sup>(e)</sup>	5	0.066 <sup>(e)</sup>	0.10 ± 0.053 <sup>(e)</sup>
	Uranium-234	1		0.57 ± 0.11	4	0.58	0.75 ± 0.13
	Uranium-235	1		0.015 ± 0.0073	5	0.017	0.024 ± 0.011
	Uranium-238	1		0.45 ± 0.089	5	0.47	1.6 ± 0.56

(a) To convert to international metric system units, multiply pCi/g by 0.037 to obtain Bq/g.

(b) Median values are not provided when only one sample analyzed.

(c) Values are ± total propagated analytical uncertainty (2-sigma).

(d) TOC = Total organic content.

(e) Below detection limit.

**Table B.8. Median Metal Concentrations (mg/kg dry wt.) in Sediment Samples Collected from the Columbia River Near the Hanford Site, 2002**

<u>Metal</u>	(n=2) <u>Priest Rapids</u> <u>Dam</u>	(n=4) <u>Hanford</u> <u>Reach<sup>(a)</sup></u>	(n=2) <u>McNary</u> <u>Dam</u>	(n=6) <u>Riverbank</u> <u>Springs<sup>(b)</sup></u>
Antimony	0.84	0.0075	0.77	0.57
Arsenic	11	6.6	8.4	5.8
Beryllium	1.9	1.6	2.0	1.5
Cadmium	7.7	0.67	1.5	0.67
Chromium	84	64	61	68
Copper	47	20	32	18
Lead	62	28	25	24
Mercury	0.17	0.0074	0.081	0.014
Nickel	44	23	30	20
Selenium	0.42	0.18	0.34	0.37
Silver	0.16	0.023	0.094	0.082
Thallium	1.4	0.62	0.80	0.56
Zinc	640	210	260	160

(a) White Bluffs Slough, 100-F Slough, Hanford Slough, and Richland.  
(b) 100-B Area, 100-K Area, 100-F Area, Hanford town site, and 300 Area.

**Table B.9. Radionuclide Concentrations Measured in Columbia River Water Samples Collected from Riverbank Springs Along the Hanford Site, 2002 Compared to Previous 5 Years**

Location/Radionuclide	2002			1997-2001			Washington State Ambient Surface Water Quality Standard, <sup>(b)</sup> pCi/L
	No. of Samples	Concentration, <sup>(a)</sup> pCi/L Maximum	Average	No. of Samples	Concentration, <sup>(a)</sup> pCi/L Maximum	Average	
<b>100-B Area</b>							
Alpha (gross)	3	2.4 ± 1.5	1.4 ± 1.9	16	9.4 ± 3.8	2.5 ± 4.2	15
Beta (gross)	3	7.3 ± 2.0	6.2 ± 1.9	16	24 ± 4.5	11 ± 13	50
Strontium-90	3	-0.0019 ± 0.24 <sup>(c)</sup>	-0.057 ± 0.12 <sup>(c)</sup>	16	7.4 ± 1.6	1.1 ± 4.8	8
Technetium-99	1	4.5 ± 0.77	--	7	10 ± 1.4	5.2 ± 6.6	900 <sup>(d)</sup>
Tritium	3	5,900 ± 360	4,800 ± 1,800	16	20,000 ± 870	9,200 ± 10,000	20,000
<b>100-D Area</b>							
Alpha (gross)	5	32 ± 9.8	13 ± 23	26	4.4 ± 2.3	1.1 ± 1.9	15
Beta (gross)	5	41 ± 8.1	23 ± 34	26	14 ± 3.6	4.1 ± 6.4	50
Strontium-90	0	--	--	12	5.3 ± 1.2	1.1 ± 2.8	8
Tritium	5	5,600 ± 380	2,600 ± 4,000	21	9,800 ± 730	3,400 ± 7,500	20,000
<b>100-F Area</b>							
Alpha (gross)	2	3.5 ± 1.8	3.4 ± 0.31	15	12 ± 3.1	4.7 ± 5.4	15
Beta (gross)	2	13 ± 3.5	12 ± 3.2	15	16 ± 2.8	8.8 ± 8.8	50
Strontium-90	2	0.13 ± 0.31 <sup>(c)</sup>	0.072 ± 0.17 <sup>(c)</sup>	15	1.5 ± 0.57	0.19 ± 0.90	8
Tritium	2	1,200 ± 190	1,200 ± 170	15	1,500 ± 320	1,000 ± 910	20,000
Uranium (total)	1	4.3 ± 0.57	--	6	5.2 ± 0.70	4.1 ± 2.1	-- <sup>(e)</sup>
<b>100-H Area</b>							
Alpha (gross)	7	1.2 ± 1.0 <sup>(c)</sup>	0.59 ± 0.93 <sup>(c)</sup>	32	10 ± 3.7	1.5 ± 3.5	15
Beta (gross)	7	13 ± 2.7	6.5 ± 10	32	72 ± 8.6	14 ± 32	50
Strontium-90	1	3.3 ± 0.71	--	10	17 ± 3.1	6.1 ± 14	8
Technetium-99	1	8.0 ± 0.97	--	10	77 ± 8.7	10 ± 48	900
Tritium	7	840 ± 170	380 ± 650	32	5,500 ± 470	990 ± 2,100	20,000
Uranium (total)	1	1.9 ± 0.26	--	10	9.3 ± 0.70	2.0 ± 5.2	--
<b>100-K Area</b>							
Alpha (gross)	4	3.4 ± 2.0	1.6 ± 2.8	19	4.1 ± 2.1	1.4 ± 2.4	15
Beta (gross)	4	13 ± 2.7	7.6 ± 7.0	19	46 ± 7.8	8.5 ± 21	50
Strontium-90	2	3.2 ± 0.72	1.6 ± 4.5	8	2.1 ± 0.52	0.60 ± 1.8	8
Technetium-99	2	1.1 ± 0.60	0.43 ± 2.0	4	2.3 ± 0.28	0.71 ± 2.1	900 <sup>(d)</sup>
Tritium	4	5,100 ± 350	1,600 ± 4,800	19	12,000 ± 970	3,100 ± 6,400	20,000

**Table B.9. (contd)**

<b>Location/Radionuclide</b>	<b>No. of Samples</b>	<b>2002</b>		<b>1997-2001</b>		<b>Washington State Ambient Surface Water Quality Standard,<sup>(b)</sup> pCi/L</b>	
		<b>Concentration,<sup>(a)</sup> pCi/L</b>	<b>Maximum</b>	<b>Average</b>	<b>Concentration,<sup>(a)</sup> pCi/L</b>	<b>Maximum</b>	<b>Average</b>
<b>100-N Area</b>							
Alpha (gross)	1	2.2 ± 1.4	--	--	2.8 ± 1.2	1.6 ± 1.4	15
Beta (gross)	1	4.8 ± 1.7	--	--	16,000 ± 1,400	2,200 ± 12,000	50
Strontium-90	1	0.0042 ± 0.0034 <sup>(c)</sup>	--	--	9,900 ± 1,800	1,600 ± 8,100	8
Tritium	1	7,100 ± 320	--	--	24,000 ± 1,900	16,000 ± 11,000	20,000
<b>300 Area</b>							
Alpha (gross)	2	81 ± 19	57 ± 69	10	230 ± 49	89 ± 110	15
Beta (gross)	2	26 ± 4.7	23 ± 9.0	10	49 ± 7.9	26 ± 23	50
Iodine-129	2	0.0042 ± 0.00047	0.0040 ± 0.00058	10	0.0067 ± 0.00066	0.0045 ± 0.0036	1
Technetium-99	0	--	--	6	16 ± 2.0	12 ± 4.8	900 <sup>(d)</sup>
Tritium	2	8,100 ± 690	7,500 ± 1,700	12	12,000 ± 580	8,800 ± 3,700	20,000
Uranium (total)	2	99 ± 11	68 ± 89	14	210 ± 26	75 ± 99	--
<b>Hanford Town Site</b>							
Alpha (gross)	2	3.0 ± 1.7	2.4 ± 1.5	10	14 ± 5.9	4.0 ± 7.3	15
Beta (gross)	2	24 ± 4.4	23 ± 0.99	10	49 ± 7.9	29 ± 18	50
Iodine-129	2	0.19 ± 0.019	0.17 ± 0.05	10	0.41 ± 0.024	0.21 ± 0.19	1
Technetium-99	2	75 ± 4.7	71 ± 11	10	120 ± 8.0	81 ± 51	900 <sup>(d)</sup>
Tritium	2	58,000 ± 1,900	56,000 ± 6,400	10	120,000 ± 8,800	85,000 ± 47,000	20,000
Uranium (total)	2	2.4 ± 0.33	2.4 ± 0.039	10	8.6 ± 1.0	3.8 ± 3.9	--

(a) Maximum values are ± total propagated analytical uncertainty. Averages are ±2 standard deviations of the calculated mean. To convert to international metric system units, multiply pCi/L by 0.037 to obtain Bq/L.

(b) WAC 246-290, 40 CFR 141, and Appendix D, Table D.2.

(c) Value below the detection limit.

(d) WAC 173-201A-050 and EPA-570/9-76-003.

(e) Dashes indicate no concentration guides available.

**Table B.10. Annual Average Dose Rates Measured On and Around the Hanford Site  
in Calendar Year 2002**

<u>Location</u>	<u>Location Number</u>	<u>Annual Average (mrem/yr)<sup>(a)</sup></u>	<u>Location</u>	<u>Location Number</u>	<u>Annual Average (mrem/yr)<sup>(a)</sup></u>
<b>Onsite<sup>(b)</sup></b>					
100 B Reactor Museum	1	87 ± 7	Community <sup>(c)</sup>	12	80 ± 8
100 K Area	2	76 ± 7	Mattawa	13	78 ± 9
100 D Area	3	87 ± 5	Othello	14	78 ± 3
100 F Met Tower	4	83 ± 9	Basin City	15	77 ± 7
N of 200 E	5	90 ± 6	Edwin Markham School	16	87 ± 9
B Pond	6	83 ± 11	Pasco	17	78 ± 7
E of 200 E	7	90 ± 8	Kennewick - Ely Street	18	86 ± 8
200ESE	8	87 ± 9	Benton City		
S of 200 E	9	95 ± 6	<b>Distant<sup>(c)</sup></b>		
200 Tel. Exchange	10	83 ± 5	Yakima	19	72 ± 5
SW of B/C Cribs	11	86 ± 15	Toppenish	20	72 ± 10
200 W SE	12	83 ± 7	<b>Columbia River Shoreline<sup>(d)</sup></b>		
Army Loop Camp	13	89 ± 8	Below 100N Outfall	1	100 ± 7
3705 Bldg. 300 Area	14	84 ± 10	Above Tip 100N Berm	2	83 ± 15
313 Bldg.	15	107 ± 6	100 N Trench Spring	3	93 ± 16
300 Water Intake	16	82 ± 6	S End Vernita Bridge <sup>(e)</sup>	4	74 ± 11
300 Southwest Gate	17	80 ± 12	Above 100 B Area	5	82 ± 18
300 South Gate	18	83 ± 8	Below 100B Ret Basin	6	95 ± 20
300 Trench	19	85 ± 4	Above 1K Boat Ramp	7	87 ± 8
300 NE	20	86 ± 7	Below 100 D Area	8	68 ± 20
400 E	21	83 ± 9	100-D Island	9	80 ± 17
400 W	22	88 ± 5	100 H Area	10	83 ± 12
400 S	23	83 ± 5	Lo End Locke Isl	11	90 ± 4
400 N	24	82 ± 4	White Bluffs Fy Lnd.	12	87 ± 15
US Ecology NE Corner	25	86 ± 3	White Bluffs Slough <sup>(f)</sup>	13	93 ± 37
US Ecology SE Corner	26	91 ± 6	Below 100 F	14	82 ± 7
US Ecology NW Corner	27	89 ± 5	100 F Flood Plain	15	97 ± 19
US Ecology SW Corner	28	99 ± 7	Hanford Slough	16	95 ± 25
Wye Barricade	29	86 ± 9	Hanford Powerline Xing	17	94 ± 2
WPPSS 1; S of WNP 2	30	83 ± 13	Hanford RR Track	18	90 ± 11
Hanford Townsite	31	78 ± 8	Savage Isl Slough	19	79 ± 9
West Lake	32	89 ± 7	Ringold Island	20	88 ± 9
LIGO	33	76 ± 6	Powerline Crossing	21	86 ± 12
<b>Perimeter<sup>(c)</sup></b>					
Ringold Met Tower	1	91 ± 8	S End Wooded Island	22	97 ± 18
W End of Fir Road	2	94 ± 5	Islnd Above 300 Area	23	94 ± 8
Dogwood Met Tower	3	94 ± 9	Island Near 300 Area	24	86 ± 14
Byers Landing	4	98 ± 5	Port of Benton-River	25	84 ± 15
Battelle Complex	5	83 ± 8	N. Richland <sup>(e)</sup>	26	76 ± 4
WPPSS 4; WPS Warehse	6	83 ± 11	Isl DS Bateman Isl <sup>(f)</sup>	27	98 ± 13
Horn Rapids Substa	7	86 ± 3			
Prosser Barricade	8	94 ± 3			
Yakima Barricade	9	98 ± 7			
Rattlesnake Springs	10	104 ± 32			
Wahluke Slope	11	94 ± 6			

- (a) ±2 standard deviations of the dose rate.
- (b) All locations are shown on Figure 4.6.1.
- (c) All locations are shown on Figure 4.6.2.
- (d) All locations are shown on Figure 4.6.3.
- (e) Moved to Shoreline grouping due to vandalism.
- (f) Only two quarters of data.

## REFERENCES

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