5.3 Surface-Water Surveillance

K. A. Saldi, R. L. Dirkes, and M. L. Blanton

Surface water on and near the Hanford Site is monitored to determine the potential effects of Hanford operations. Surface water at Hanford includes the Columbia River, riverbank springs, ponds located on the Hanford Site, and offsite water systems directly east and across the Columbia River from the Hanford Site. Columbia River sediments are also included in this discussion. Tables 5.3.1 and 5.3.2 summarize the sampling locations, sample types, sampling frequencies, and sample analyses included in surface-water surveillance activities during 1994. Sample locations are also identified in Figure 5.3.1. This section describes the surveillance effort and summarizes the results for these aquatic environments. Detailed analytical results are reported by Bisping (1995).

Columbia River Water

The Columbia River, which flows through the northern portion and forms part of the eastern boundary of the Hanford Site, is the dominant surface-water body on the Site. The river is used as a source of drinking water for onsite facilities and by communities located downstream from the Hanford Site. In addition, the Hanford Reach of the Columbia River is used for a variety of recreational activities, including hunting, fishing, boating, water-skiing, and swimming. Water from the Columbia River downstream from the Site is also used extensively for crop irrigation.

Originating in the mountains of eastern British Columbia, Canada, the Columbia River drains a total area of approximately 70,800 km^2 (27,300 mi^2) en route to the Pacific Ocean. Flow of the Columbia River is regulated by 11 dams within the United States, seven upstream and four downstream from the Site. Priest Rapids is the nearest dam upstream, and McNary is the nearest dam downstream from the Site. The Hanford Reach of the Columbia River extends from Priest Rapids Dam to the head of Lake Wallula (created by McNary Dam), near Richland. This Reach is the last stretch of the Columbia River in the United States above Bonneville Dam that remains unimpounded. The width of the river varies from approximately 300 m (984 ft) to 1,000 m (3,281 ft) within the Hanford Site. The Hanford Reach is currently under consideration for designation as a National Wild and Scenic River as a result of congressional action in 1988.

Pollutants, both radiological and nonradiological, are known to enter the river along the Hanford Site. In addition to direct discharges of liquid effluents from Hanford facilities, contaminants in ground water from past discharges to the ground are known to seep into the river (Dirkes 1990, DOE 1992c, McCormack and Carlile 1984, Peterson 1992). Effluents from each direct discharge point are routinely monitored and reported by the responsible operating contractor; they are summarized in Section 3.1, "Facility Effluent Monitoring." Direct discharges are identified and regulated for nonradiological constituents under the National Pollutant Discharge Elimination System. The National Pollutant Discharge Elimination System-permitted discharges at Hanford and the regulated parameters are listed in Appendix C, Table C.7.

The state of Washington has classified the stretch of the Columbia River from Grand Coulee Dam to the Washington-Oregon border, which includes the Hanford Reach, as Class A, Excellent (Ecology 1992). Water quality criteria and water use guidelines have been established in conjunction with this designation (Appendix C, Table C.1). The state of Washington and EPA Drinking Water Standards used in evaluating radionuclide concentrations in Columbia River water are provided in Appendix C, Table C.2.

Sample Collection and Analysis

Samples of Columbia River water were collected throughout 1994 by the Surface Environmental Surveillance Project at the locations shown in Figure 5.3.1. Samples were collected upstream from Hanford facilities at Priest Rapids Dam and near the Vernita Bridge to provide background data from locations unaffected by Site operations. Samples were collected from the Richland Pumphouse to identify any increase in contaminant concentrations

Table 5.3.1 Surface-Water Surveillance, 1994

Location	Sample Type	Frequency[a]	Analyses
Columbia River - Radiological			
Priest Rapids Dam and Richland	Cumulative	M Comp[b]	Alpha, beta, lo ^{3}H[c], gamma scan, ^{90}Sr, ^{99}Tc, U[d]
Priest Rapids Dam and Richland	Particulate (filter)	M Q Comp	Gamma scan Pu[e]
Priest Rapids Dam and Richland	Soluble (resin)	M Q Comp	Gamma scan 129I, Pu(e)
Vernita Bridge and Richland	Grab (transects)	Q	lo ^{3}H, ^{90}Sr, U[d]
100-F and 300 Area	Grab (transects)	A	lo ^{3}H, ^{90}Sr, U[d]
100-N	Grab (transects)	A	Alpha, beta, lo ^{3}H, ^{90}Sr, ^{99}Tc, U[d], gamma scan
Hanford Townsite	Grab (transects)	A	lo ^{3}H, ^{90}Sr, ^{99}Tc, U[d]
Columbia River - Nonradiological			
Vernita and Richland	Grab	Q[f]	WQ-NASQAN, temperature, dissolved oxygen, turbidity, pH, fecal coliforms, suspended solids, dissolved solids, conductivity, hardness as $CaCO_3$, P, Cr, N-Kjeldahl, dissolved oxygen content, Fe, NH_3
Vernita and Richland	Grab (transects)	Q	ICP[g] metals, anions, volatile organics
100-N, 100-F, Hanford Townsite, and 300 Area	Grab (transects)	A	ICP metals, anions, volatile organics
Onsite Ponds			
West Lake	Grab	Q	Alpha, beta, ^{3}H, ^{90}Sr, ^{99}Tc, U[d], gamma scan
B Pond	Grab	Q	Alpha, beta, ^{3}H, ^{90}Sr, ^{99}Tc, gamma scan
FFTF Pond	Grab	Q	Alpha, beta, ^{3}H, gamma scan
Offsite Water			
Ringold Hatchery, Mathews Corner, White Bluffs shallow, White Bluffs deep, and Alexander Farm	Grab	A	Alpha, beta, ^{3}H, U[d], gamma scan
Riverview Canal	Grab	3[h]	Alpha, beta, ^{3}H, ^{90}Sr, U[d], gamma scan
Riverbank Springs			
100-B, 100-K, 100-N, 100-D, and 100-H	Grab	2[i]	Alpha, beta, ^{3}H, ^{90}Sr, ^{99}Tc, U[d], gamma scan, ICP metals, anions, volatile organics
Hanford Townsite, 300 Area	Grab	2[i]	Alpha, beta, ^{3}H, ^{129}I, ^{90}Sr, ^{99}Tc, U[d], gamma scan, ICP metals, anions, volatile organics

(a) A = annually; M = monthly; Q = quarterly; Comp = composite.
(b) M Comp is collected weekly and composited for monthly analysis.
(c) lo ^{3}H = low-level tritium analysis.
(d) Isotopic uranium.
(e) Isotopic plutonium.
(f) Numerous water quality analyses are performed by the U.S. Geological Survey (USGS) in conjunction with the National Stream Quality Accounting Network (NASQAN) Program. Thermograph stations are operated and maintained by the USGS.
(g) ICP = inductively coupled plasma analysis method.
(h) Three samples during irrigation season.
(i) Two samples during period of low river flow (August-September).

Table 5.3.2 Sediment Surveillance, 1994

Location[a]	Frequency	Analyses
River		
McNary Dam		
Oregon shore	A[b]	Gamma scan, ^{90}Sr, U[c], Pu[d], ICP[e] Metals
1/3 from Oregon shore	A	Gamma scan, ^{90}Sr, U[c], Pu[d], ICP[e] Metals
2/3 from Oregon shore	A	Gamma scan, ^{90}Sr, U[e], Pu[d], ICP[e] Metals
Washington shore	A	Gamma scan, ^{90}Sr, U[c], Pu[d], ICP[e] Metals
Priest Rapids Dam		
Grant County shore	A	Gamma scan, ^{90}Sr, U[c], Pu[d], ICP[e] Metals
1/3 from Grant County shore	A	Gamma scan, ^{90}Sr, U[c], Pu[d], ICP[e] Metals
2/3 from Grant County shore	A	Gamma scan, ^{90}Sr, U[c], Pu[d], ICP[e] Metals
Yakima County shore	A	Gamma scan, ^{90}Sr, U[c], Pu[d], ICP[e] Metals
White Bluffs Slough	A	Gamma scan, ^{90}Sr, U[c], Pu[d], ICP[e] Metals
100-F Slough	A	Gamma scan, ^{90}Sr, U[c], Pu[d], ICP[e] Metals
Hanford Slough	A	Gamma scan, ^{90}Sr, U[c], Pu[d], ICP[e] Metals
Richland	A	Gamma scan, ^{90}Sr, U[c], Pu[d], ICP[e] Metals
Springs		
100-N Spring 8-13	A	Gamma scan, ^{90}Sr, U[c], ICP Metals
Hanford Spring 28-2	A	Gamma scan, ^{90}Sr, U[c], ICP Metals
300 Area Spring 42-2	A	Gamma scan, ^{90}Sr, U[c], ICP Metals

(a) See Figure 5.8.
(b) A = annually
(c) Includes ^{235}U and ^{238}U analyzed by low-energy photon analysis.
(d) Isotopic plutonium.
(e) Inductively coupled plasma analysis method.

at this location attributable to Hanford operations. The Richland Pumphouse is the first downstream point of river water withdrawal for a public drinking water supply. The river sampling locations and the methods used for sample collection are discussed in detail in the *Hanford Site Environmental Monitoring Plan* (DOE 1994c). In addition to the routine single-point intake, fixed-location monitoring stations described in the environmental monitoring plan, routine sampling was performed along cross sections of the Columbia River at the Vernita Bridge, 100-N Area, 100-F Area, old Hanford Townsite, 300 Area, and the Richland Pumphouse. The transect sampling was initiated as a result of findings of a special study conducted during 1987 and 1988 (Dirkes 1993). This study concluded that under certain flow conditions contaminants entering the river from Hanford are not completely mixed at routine Surface Environmental Surveillance Project river monitoring stations. Incomplete mixing results in a slight conservative bias in the data generated using the routine single-point sampling systems at the 300 Area and the Richland Pumphouse. The cross sections at Vernita Bridge and the Richland Pumphouse were sampled quarterly during 1994. Annual transect sampling was conducted at the 100-N Area, 100-F Area, old Hanford Townsite, and 300 Area sampling locations.

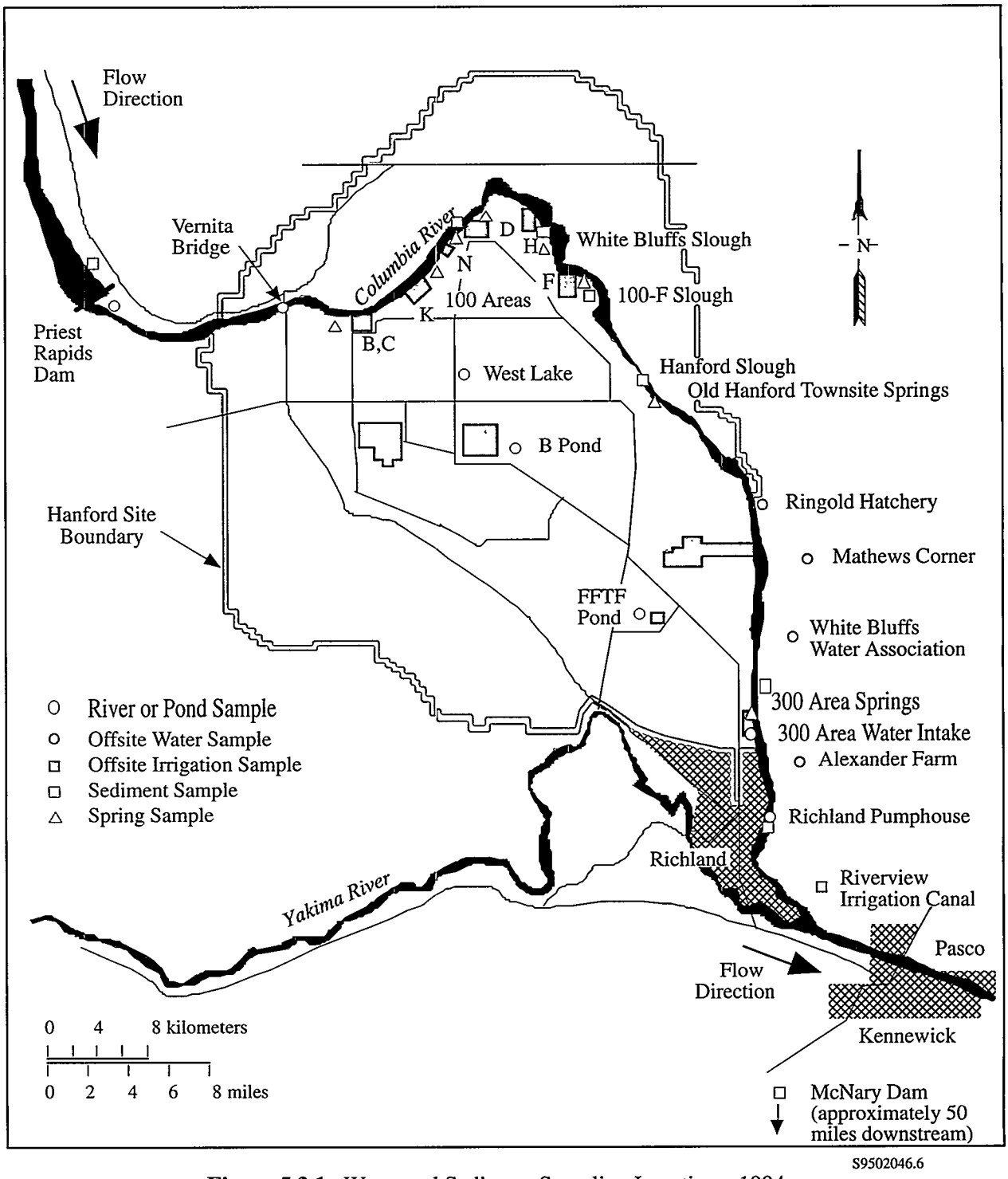

Figure 5.3.1 Water and Sediment Sampling Locations, 1994

Radiological analyses of water samples collected from the Priest Rapids Dam and Richland Pumphouse monitoring stations included gamma scan, iodine-129, plutonium-238, plutonium-239,240, strontium-90, technetium-99, total alpha, total beta, tritium, uranium-234, -235, and -238. Analyses of cumulative river samples (Table 5.3.1) were performed on unfiltered samples. Analyses of filters and resins were performed on particulate and soluble fractions of Columbia River water, respectively. Alpha and beta measurements provided a general indication of the radioactive contamination.

Gamma scans provided the ability to detect numerous specific radionuclides (Appendix F). Sensitive radiochemical analyses and, in some cases, special sampling techniques were used to determine the concentrations of iodine-129, plutonium-238, plutonium-239,240, strontium-90, technetium-99, tritium, uranium-234, -235, and -238 in river water during the year. Radionuclides of interest were selected based on their presence in effluent discharges or ground water near the river, and their importance in determining water quality, verifying effluent control and effluent monitoring systems, and determining compliance with applicable standards. Columbia River transect samples collected in 1994 were analyzed for both radiological and chemical contaminants (Table 5.3.1). Metals, anions, and volatile organics of interest, listed in DOE (1994c), were determined from reviews of existing surface- and ground-water data, various Remedial Investigation/ Feasibility Study work plans, and preliminary Hanford Site risk assessments (Dirkes et al. 1993, DOE 1992b, Evans et al. 1992). All radiological and chemical analyses of transect samples were performed on unfiltered samples.

In addition to Columbia River monitoring conducted by the Surface Environmental Surveillance Project, nonradiological water quality monitoring was also performed by the U.S. Geological Survey (USGS) at the Vernita Bridge and the Richland Pumphouse. During 1994, USGS samples were collected along cross sections every 2 months at the Vernita Bridge and quarterly at the Richland Pumphouse. Sample analyses were performed at the USGS laboratory in Denver, Colorado for numerous physical, biological, and chemical constituents. Results of USGS monitoring activities are documented in Bisping (1995).

Radiological Results for River Water

Results of the radiological analyses of Columbia River water samples collected by the Surface Environmental Surveillance Project at Priest Rapids Dam and the Richland Pumphouse during 1994 are reported by Bisping (1995) and summarized in Appendix A, Tables A.1 and A.2. Samples of Columbia River water were also collected by the Drinking Water Monitoring Program in 1994 at the 300 Area water intake. The 300 Area monitoring results are reported by the Hanford Environmental Health Foundation and are summarized in Appendix A, Table A.3. Tables A.1 through A.3 list the maximum and mean concentrations of select radionuclides observed in 1994 and during the previous 5 years. All radiological contaminant concentrations measured in the Columbia River in 1994 were less than DOE Derived Concentration Guides and state of Washington and EPA Drinking Water Standards (Appendix C, Tables C.6. and C.2., respectively). Significant results are discussed and illustrated below, and comparisons to previous years are provided.

Levels of radionuclides monitored in Columbia River water were extremely low throughout the year. Radionuclides consistently detected in river water collected from monitoring stations during 1994 at concentrations greater than their 2 sigma total propagated analytical uncertainty included iodine-129, plutonium-239,240, strontium-90, tritium, uranium-234, and -238. The concentrations of all other measured radionuclides were less than their respective 2 total propagated analytical uncertainties in over 75% of samples collected. Iodine-129, plutonium-239,240, strontium-90, and tritium exist in worldwide fallout, as well as in effluents from Hanford facilities. Tritium and uranium occur naturally in the environment in addition to being present in Hanford effluents.

Total alpha and total beta measurements are useful indicators of the general radiological quality of the river and provide an early indication of changes in the levels of radioactive contamination because results are obtained quickly. Figures 5.3.2 and 5.3.3 illustrate the average annual total alpha and total beta concentrations, respectively, at Priest Rapids Dam and the Richland Pumphouse during the past 6 years. The 1994 average total alpha and total beta concentrations were similar to those observed during recent years. Monthly total alpha concentrations measured at the Richland Pumphouse in 1994 were not significantly different (paired sample comparison and t-test of differences, 5% significance level) from those measured at Priest Rapids Dam. Monthly total beta concentrations, however, were significantly lower at the Richland Pumphouse. The 1994 total alpha and beta concentrations in Columbia River water at Priest Rapids Dam and the Richland Pumphouse were less than 10% of the

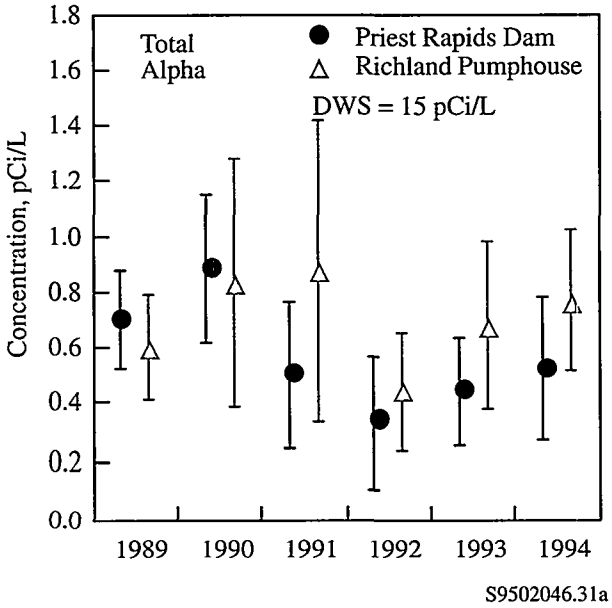

Figure 5.3.2 Annual Average Total Alpha Concentrations (± 2 standard error of the mean) in Columbia River Water, 1989 Through 1994

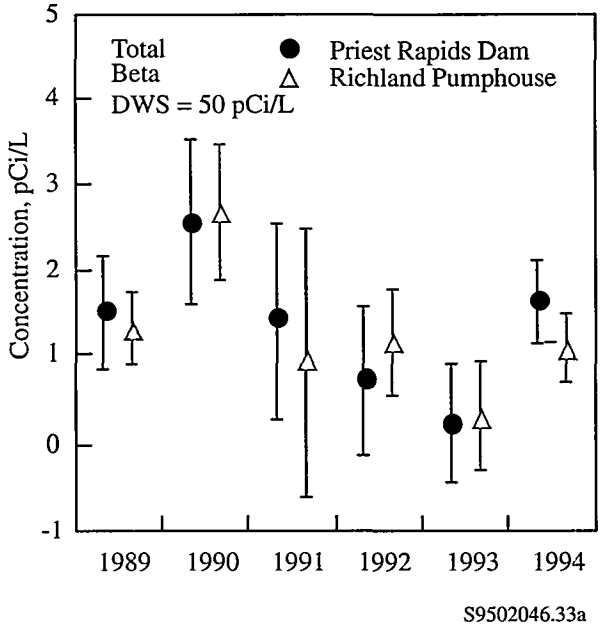

Figure 5.3.3 Annual Average Total Beta Concentrations (± 2 standard error of the mean) in Columbia River Water, 1989 Through 1994

applicable Drinking Water Standards of 15 and 50 pCi/L, respectively.

Figure 5.3.4 compares the average annual tritium concentrations at Priest Rapids Dam and the Richland Pumphouse from 1989 through 1994. The

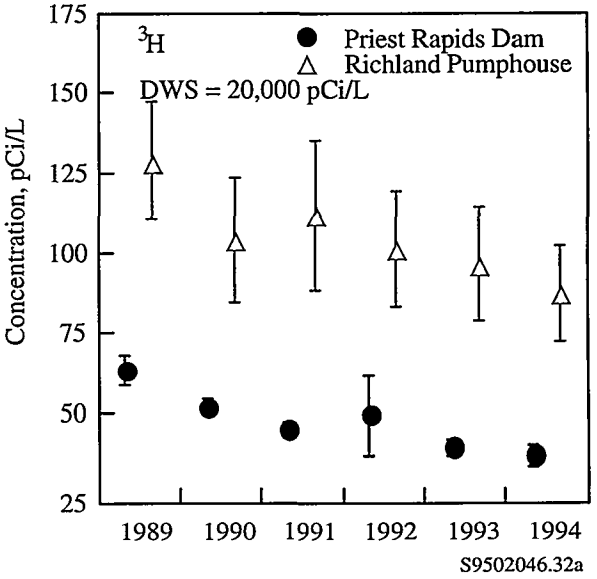

Figure 5.3.4 Annual Average Tritium Concentrations (± 2 standard error of the mean) in Columbia River Water, 1989 Through 1994. As a result of figure scale, some uncertainties (error bars) are concealed by point symbol.

general decline in tritium concentrations in river water noted during the late 1980s remains evident at both locations. Statistical analysis (paired sample comparison, t-test of differences, 5% significance level) indicated that monthly tritium concentrations in river water at the Richland Pumphouse were significantly higher than those at Priest Rapids Dam. Onsite sources of tritium entering the river include ground-water seepage and direct discharge from outfalls located in the 100 Area (see Section 3.1, "Facility Effluent Monitoring," and Section 5.8, "Ground-Water Protection and Monitoring Program"). Tritium concentrations measured at the Richland Pumphouse, while representative of the Columbia River source of City of Richland drinking water, tend to overestimate the average concentrations of tritium in the river at this location (Dirkes 1993). This bias is attributable to the contaminated 200 Area ground-water plume entering the river along the portion of shoreline extending from the old Hanford Townsite to below the 300 Area, which is relatively close to the Richland sample intake. This plume is not completely mixed within the river at the Richland Pumphouse. Sampling along a cross section at the Richland Pumphouse during 1994 confirmed the existence of a concentration

gradient in the river under certain flow conditions and is discussed in subsequent sections of this report. The extent to which samples taken from the Richland Pumphouse overestimate the average tritium concentrations in the Columbia River at this location is highly variable and appears to be related to the flow rate of the river just before and during sample collection. All tritium concentrations were less than 1% of the state of Washington and EPA Drinking Water Standard of 20,000 pCi/L.

The annual average strontium-90 concentrations at Priest Rapids Dam and the Richland Pumphouse during 1994 was 0.09 ± 0.01 pCi/L at both locations. Figure 5.3.5 shows the average annual strontium-90 concentrations at these locations from 1989 through 1994. Concentrations observed in 1994 were similar to those seen in recent years. The differences between monthly strontium-90 concentrations at Priest Rapids Dam and the Richland Pumphouse observed in 1994 were not significant (paired sample comparison, t-test of differences, 5% significance level). The primary source of strontium-90 entering the Columbia River and attributable to Hanford has been the 100-N Area liquid waste disposal facilities, which are known to discharge to the river via ground water. Average strontium-90 concentrations in Columbia River water collected from Priest Rapids Dam and the Richland Pumphouse during 1994 remained less than 2% of the State of Washington and EPA Drinking Water Standard of 8 pCi/L.

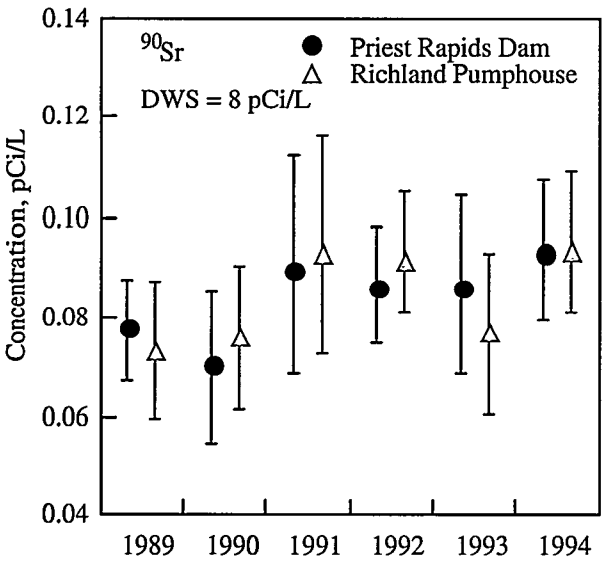

Figure 5.3.5 Annual Average Strontium-90 Concentrations (± 2 standard error of the mean) in Columbia River Water, 1989 Through 1994

Average annual total uranium concentrations (i.e., the sum of uranium-234, -235, and -238 concentrations) at the Richland Pumphouse and Priest Rapids Dam for 1989 through 1994 are shown in Figure 5.3.6. Total uranium concentrations observed in 1994 were similar to those observed during recent years. The larger 2 standard error of the mean associated with 1994 results was attributed to an unusually low concentration found in the December sample of each location. Although there is no direct discharge of uranium to the river, uranium is present in the ground water beneath the 300 Area as a result of past Hanford operations (see Section 5.8, "Ground-Water Protection and Monitoring Program") and has been detected at elevated levels in riverbank springs in this area (see Riverbank Springs subsection). Naturally occurring uranium is also known to enter the river across from Hanford via seepage from extensive irrigation east of the river and via irrigation canal outfalls (Dirkes 1990). Though monthly total uranium concentrations measured at the Richland Pumphouse in 1994 were slightly higher than those measured at Priest Rapids

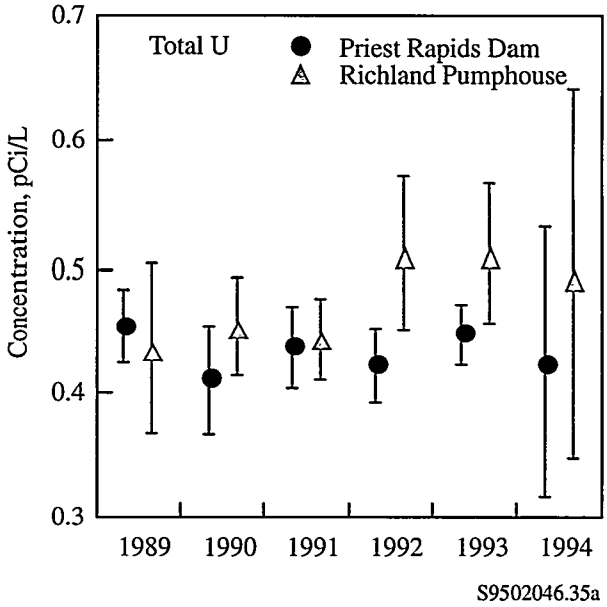

Figure 5.3.6 Annual Average Uranium (Uranium-234 + Uranium-235 + Uranium-238) Concentrations (± 2 standard error of the mean) in Columbia River Water, 1989 Through 1994

Dam, the differences were not statistically significant (paired sample comparison, t-test of differences, 5% significance level). There is currently no Drinking Water Standard directly applicable to uranium. However, total uranium concentrations in the river during 1994 were well below the proposed EPA Drinking Water Standard of 20 µg/L (30 pCi/L).

Figure 5.3.7 presents the average annual iodine-129 concentrations (aCi/L units) for Priest Rapids Dam and the Richland Pumphouse for 1989 through 1994. The average concentration of iodine-129 in Columbia River water was extremely low during 1994 (less than one-tenth of 1% of the Drinking Water Standard of 1 pCi/L [1,000,000 aCi/L]) and similar to levels observed during recent years. The onsite source of iodine-129 to the Columbia River in 1994 was the discharge of contaminated ground water along the portion of shoreline extending from the old Hanford Townsite to below the 300 Area. The iodine-129 plume originated in the 200 Area from past waste disposal practices. Unlike past findings, average concentrations of iodine-129 measured at the Priest Rapids Dam (43.1 ± 59.0 aCi/L) and the Richland Pumphouse 76.5 ± 26.6 aCi/L) in 1994 were not statistically significant (paired sample comparison and t-test of differences, 5% significance level). The lack of significance is attributable to third quarter results for which the iodine-129 concentration was higher at Priest Rapids Dam than at the Richland Pumphouse. The unusually high concentration observed at Priest Rapids Dam is reflected in the 2 standard error of the mean (Figure 5.3.7).

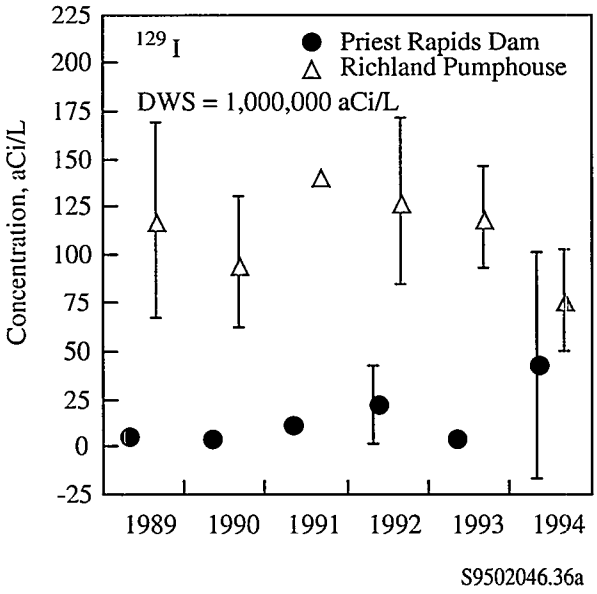

Figure 5.3.7 Annual Average Iodine-129 Concentrations (± 2 standard error of the mean) in Columbia River Water, 1989 Through 1994. As a result of figure scale, some uncertainties (error bars) are concealed by point symbol.

During 1994, average plutonium-239,240 concentrations at Priest Rapids Dam and the Richland Pumphouse were 4.47 ± 120 aCi/L and 74.7 ± 40.4 aCi/L, respectively. No Washington State or EPA Drinking Water Standard currently exists for plutonium-239 or plutonium-240; however, if the Derived Concentration Guides (Appendix C, Table C.6.), which are based on a 100-mrem dose standard, are converted to a 4-mrem dose equivalent used to develop the Drinking Water Standards, 1.2 pCi/L (1,200,000 aCi/L) would be the relevant guideline for both plutonium-239 and plutonium-240. Concentrations of plutonium-239,240 at Priest Rapids Dam were not statistically different from those observed at the Richland Pumphouse during 1994 (paired sample comparison, t-test of differences, 5% significance level).

Radiological results of samples collected along cross sections of the Columbia River established at the Vernita Bridge, 100-N Area, 100-F Area, old Hanford Townsite, 300 Area, and the Richland Pumphouse during 1994 are presented in Appendix A, Table A.4 and in Bisping (1995). Constituents that were consistently detected (in greater than 50% of river transect samples) at concentrations greater than their associated 2 total propagated analytical uncertainty included strontium-90, tritium, uranium-234, and -238. All measured radionuclide concentrations were less than applicable Washington State and federal Drinking Water Standards.

Mean strontium-90 and tritium concentrations measured along cross sections of the Columbia River during 1994 are depicted in Figures 5.3.8 and 5.3.9, respectively. The reported result is plotted for those transects that were sampled only once in 1994. The transects are displayed such that the observer's view is downstream. Vernita Bridge is the most upstream transect. Stations 1 and 10 are located along the

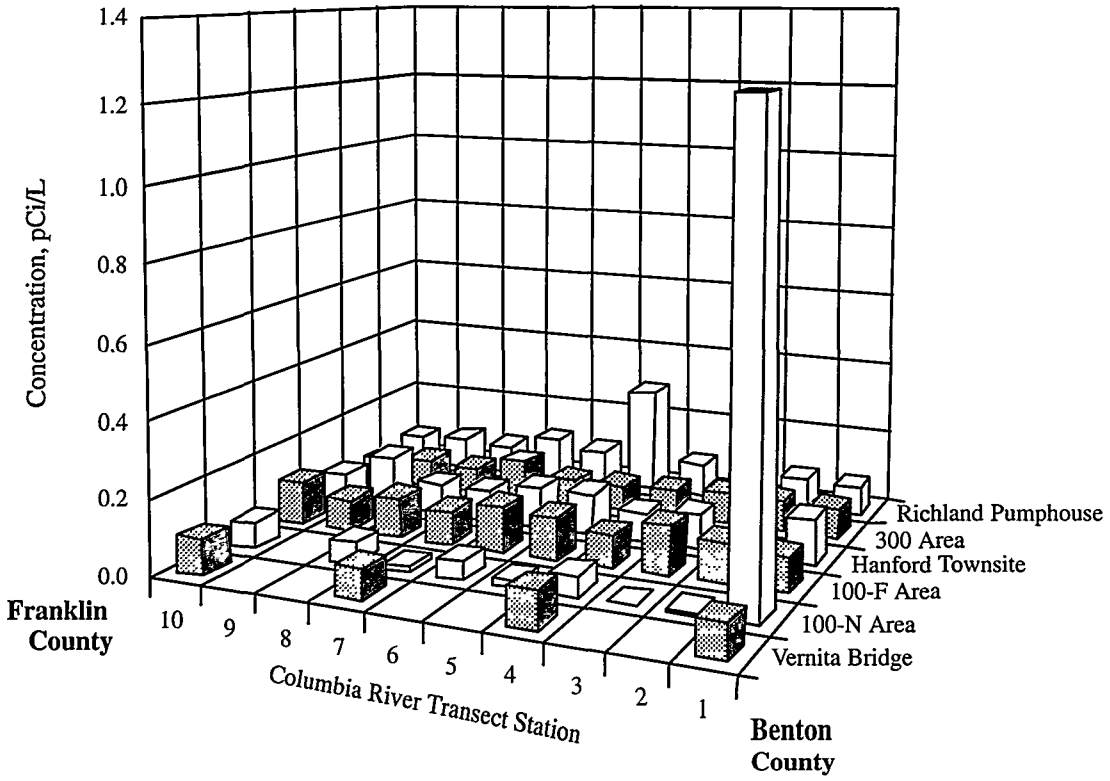

Figure 5.3.8 Mean Strontium-90 Concentrations in Columbia River Transects During 1994

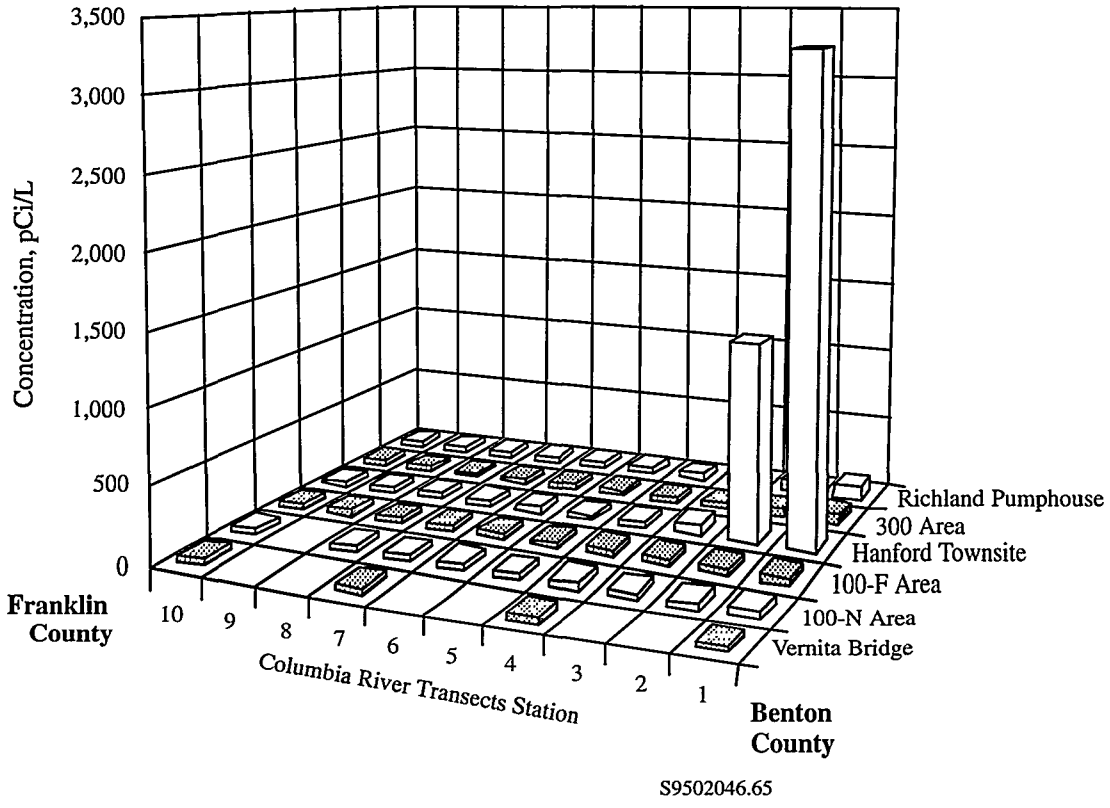

Figure 5.3.9 Mean Tritium Concentrations in Columbia River Transects During 1994

Benton County and Franklin County shorelines, respectively.

Strontium-90 levels in 1994 transect samples (Figure 5.3.8) were elevated along the 100-N Area shoreline. This observation concurred with recent Hanford ground-water reports (Dresel et al. 1994) indicating that the highest shoreline concentrations of strontium-90 existed in the 100-N Area. With the exception of the 100-N Area transect, strontium-90 concentrations were fairly uniform across the width of the river. The mean concentration of strontium-90 found during cross-sectional sampling at the Richland Pumphouse was similar to that obtained from the routine single-intake automatic composite sampler used at that location.

The highest tritium concentrations observed in 1994 river transect water (Figure 5.3.9) were detected along the shoreline of the old Hanford Townsite where ground water containing tritium concentrations in excess of the Drinking Water Standard of 20,000 pCi/L is known to discharge to the river (Dresel et al. 1994). Elevated levels of tritium were also evident near the Hanford shoreline at the 100-N Area, 300 Area, and Richland Pumphouse transect locations. The presence of a tritium concentration gradient in the Columbia River at the Richland Pumphouse supports previous conclusions made by Backman (1962) and Dirkes (1993) that contaminants in the 200 Area ground-water plume entering the river at and upstream of the 300 Area are not completely mixed at the Richland Pumphouse. The mean concentration of tritium measured along the cross section established at the Richland Pumphouse was less than that measured using the single-intake sampler located near the western shoreline of the river.

Total uranium concentrations in 1994 were elevated along both the Benton and Franklin County shorelines of the 300 Area and Richland Pumphouse transects. The highest total uranium concentration was measured near the Franklin County shoreline of the 300 Area transect and likely resulted from irrigation returns. The mean concentration of total uranium across the Richland Pumphouse transect was similar to that obtained from the routine single-intake automatic composite sampler used at that location.

Nonradiological Results for River Water

Nonradiological water quality data were compiled by the Surface Environmental Surveillance Project and the USGS during 1994. A number of the parameters measured have no regulatory limits; however, they are useful as indicators of water quality and/or Hanford-origin contaminants. Potential sources of pollutants not associated with Hanford include irrigation return water and ground-water seepage associated with extensive irrigation north and east of the Columbia River.

Figure 5.3.10 shows the Vernita Bridge and the Richland Pumphouse USGS results for 1989 through 1994 for several water quality parameters with respect to the applicable standards. In accordance with Washington State Water Quality Standards (Appendix C, Table C.1.), fecal coliform results are presented as annual geometric means (i.e., the antilogarithm of the arithmetic mean of the logarithms of the individual sample values). Turbidity and dissolved oxygen results are presented as annual arithmetic means. The complete list of results obtained through the USGS national water quality network are summarized in Appendix A, Table A.5. The 1994 USGS results were comparable to those reported during the previous 5 years. Applicable standards for a Class A-designated surface-water body were met. During 1994, there was no indication of any deterioration of water quality resulting from Hanford operations along the Hanford Reach of the Columbia River.

Results of nonradiological sampling conducted by the Surface Environmental Surveillance Project along cross sections of the Columbia River at the Vernita Bridge, 100-N Area, 100-F Area, old Hanford Townsite, 300 Area, and the Richland Pumphouse are provided by Bisping (1995). The concentrations of volatile organics, metals, and anions observed in river water in 1994 were similar to those observed in the past (Dirkes et al. 1993). Volatile organic compounds were not routinely detected; those that were detected in 1994 included acetone (in one of a total of 94 samples collected) and methylene chloride. Average annual concentrations of both compounds were higher at the Vernita Bridge than at the Richland Pumphouse. Neither compound displayed elevated concentrations along the Hanford shoreline of the Columbia River.

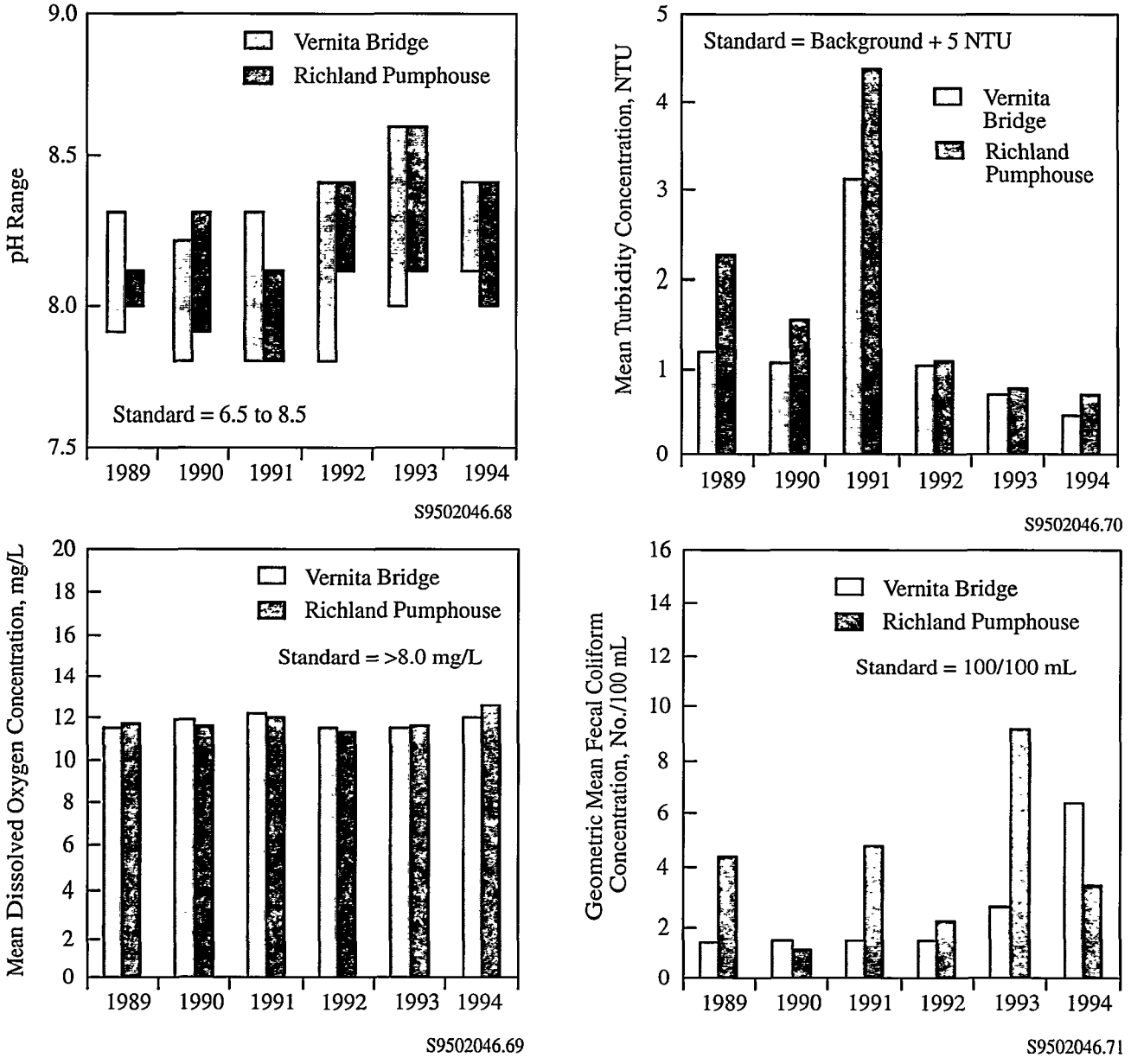

Figure 5.3.10 USGS Columbia River Water Quality Measurements, 1989 Through 1994

Several metals and anions were detected both upstream and downstream of the Hanford Site at levels comparable to those reported by the USGS as part of their ongoing national water quality monitoring network. With the exception of magnesium and manganese, whose average quarterly concentrations were highest at the Richland Pumphouse, no consistent differences were found between average quarterly contaminant concentrations in the Vernita Bridge and Richland Pumphouse samples. All metal and anion concentrations in river water were less than primary Washington State and federal Drinking Water Standards (Appendix C, Table C.3).

However, aluminum and iron concentrations in Columbia River water collected along the Hanford shoreline at the 300 Area exceeded their respective secondary Drinking Water Standards. Secondary Drinking Water Standards are based on factors other than health effects. Elevated concentrations of aluminum and iron were also observed in Columbia River springs in the 300 Area during 1994 (see Riverbank Springs subsection). Other contaminants with elevated concentrations measured near the Hanford shoreline included manganese in the 300 Area transect and nitrate in the old Hanford Townsite transect. The highest nitrate concentrations,

however, were measured on the Franklin County shoreline and likely resulted from irrigation returns.

The annual average flow rate of the Columbia River at Priest Rapids Dam was 2,673 m^3/s (94,400 cfs) during 1994, similar to that reported in recent years. The monthly average flow rates at Priest Rapids Dam are shown in Figure 5.3.11. The peak monthly average flow rate occurred during June (4,288 m^3/s [151,430 cfs]), and the lowest monthly average flow rate occurred during September (1,700 m^3/s [60,050 cfs]). Daily average flow rates varied from 1,045 to 5,097 m^3/s (36,900 to 180,000 cfs) during 1994.

Columbia River Sediment

In 1994, numerous studies were conducted on various aspects of sediment contamination in the Columbia River. This section will discuss the results of 1994 sediment surveillance activities. In addition, special studies or activities in 1994 that are pertinent to the evaluation of Columbia River sediment contamination will also be discussed.

Sample Collection and Analysis

Samples of Columbia River surface sediments (1-5 cm) were collected at 12 stations from six annual monitoring sites (shown in Figure 5.3.1 and summarized in Table 5.3.2) during 1994. Monitoring sites located at McNary and Priest Rapids Dams consisted of a transect with four stations established

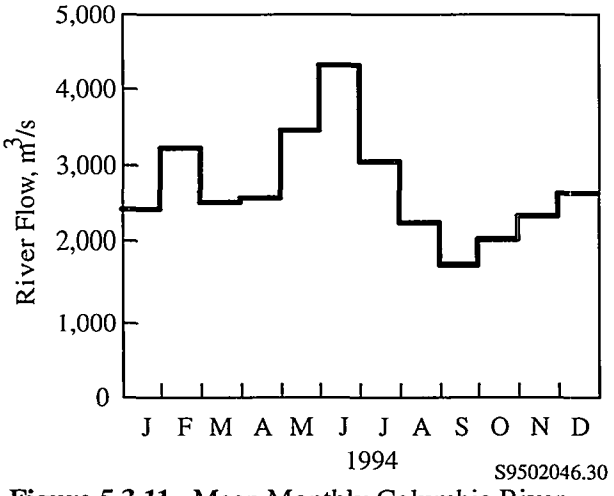

Figure 5.3.11 Mean Monthly Columbia River Flow Rates During 1994 (measured at Priest Rapids Dam)

across the river at approximately equal distances. At the Hanford Reach sampling locations (White Bluffs Slough, 100-F Slough, Hanford Slough, and Richland Pumphouse), a single near-shore grab sample (Hanford Site shoreline) was collected. A sample was taken at each sampling point using a Petite Ponar Grab sampler with a 235-cm^2 opening. Sediment samples were analyzed for gamma emitters (see Appendix F), plutonium-238, plutonium-239, plutonium-240, strontium-90, uranium-235, -238, and ICP metals (DOE 1994c). The sampling locations and methods used are discussed in detail in the *Environmental Monitoring Plan* (DOE 1994c).

Sediment Monitoring Results and Discussion

Sediments in the Columbia River contain low levels of radionuclides and metals of Hanford origin and radionuclides from nuclear weapons testing fallout (Beasley et al. 1981, Robertson and Fix 1977, Woodruff et al. 1992, Blanton et al. 1995). Hanford Site-derived pollutants are transported in surface waters in particulate or dissolved form. In fluvial systems, particulate transport is based on particle size, particle density, and water velocity. Contaminants associated with minerals are transported and deposited differently than contaminants associated with organic carbon. Organic carbon content of sediments is associated with the finer grained size fractions. Thus, areas where water velocity is reduced (slack water) will have a higher composition of fine-grained sediment and organic carbon content. Sediment grain size and total organic carbon content varied greatly among sediment monitoring site locations (Blanton et al. 1995). Consequently, concentrations of contaminants in sediments can vary significantly depending on sediment makeup and particle size distribution. Therefore, direct comparisons between bulk sediment contaminant concentrations among monitoring stations at Priest Rapids Dam, the Hanford Reach, and McNary Dam must consider the effects of grain size and total organic carbon content on sediment contaminant sorption. These factors were considered in the following discussion of the 1994 sediment monitoring results. The results and discussion are presented for both individual monitoring sites and regional means. Regional means include the sampling stations in the Priest Rapids and McNary Dams transects as well as the Hanford Reach stations of

White Bluffs, 100-F Area and Hanford Sloughs, and the Richland Pumphouse. All 1994 data collected for both radionuclides and chemicals (metals, inorganics) in sediments is reported in Bisping (1995). For more detailed information on sediment grain size and contaminant associations see Blanton et al. (1995).

In general, radiological analytical results for surface sediment samples collected during 1994 (Appendix A, Table A.6) were very low or below the minimum detection levels at all sites sampled. Appendix A, Table A.6 summarizes data for 1989 through 1993. The McNary Dam site had the highest concentrations of radionuclides during 1994. However, no appreciable differences existed between the Priest Rapids Dam reference site and the Hanford Reach or McNary Dam stations (Figure 5.3.12). Radionuclide concentration measured during 1994 were similar to those in sediment samples collected during the previous 5 years. The downriver trend in radionuclide concentration described above was expected based on examination of the grain size distribution and total organic carbon content of sediment collected from each monitoring site location (Blanton et al. 1995).

A summary of 1994 metal (and other inorganics) results is provided in Appendix A, Table A.7. All metal concentrations analyzed were detected above the minimum detection level. In general, mean metal concentrations along the Hanford Reach and at McNary Dam were not significantly different (based on the standard error of the mean) than those found at Priest Rapids Dam. (Figure 5.3.13). Mean chromium concentrations in sediment along the Hanford Reach appeared to be slightly elevated when compared to Priest Rapids and McNary Dams. A single elevated result at 100-F Slough (100 mg/kg) accounts for the increase in the mean chemical concentration. Generally, concentrations of metals at monitoring locations support the grain size and total organic carbon data reported in Blanton et al. 1995.

Review of 1994 Special Studies on Columbia River Sediments

Factors Controlling Sediment Contaminant Sorption

A special sediment monitoring study was conducted in 1994 to investigate the difference in sediment grain size composition and total organic carbon content at established monitoring sites. The study also determined if associations exist between sediment contaminant burden, grain size composition and total organic carbon content. During this study, sediments at the six Columbia River monitoring locations (Figure 5.3.1) were analyzed for grain size, total organic carbon content, radionuclides, metals, polycyclic aromatic hydrocarbons, polychlorinated biphenyls, and pesticides (Blanton et al. 1995). Sediment grain size and total organic carbon influence contaminant fate and transport. In general, river sediments with higher total organic carbon and finer grain size distribution can have higher contaminant burdens than sediments with less total organic carbon and more coarse–grained sediments. Physicochemical sediment characteristics were found to be highly variable among monitoring sites along the Columbia River. Again, sediment grain size and total organic carbon content should be considered in interpretations of sediment monitoring data. Additional detailed information on specific grain size and total organic carbon characteristics for individual monitoring sites is provided in Blanton et al. (1995).

Columbia River Comprehensive Impact Assessment: Distribution of Sediment Contamination

In 1994, the Surface Environmental Surveillance Program, in conjunction with the Columbia River Comprehensive Impact Assessment Program, analyzed sediment samples taken at 29 different locations along the Columbia River, from Priest Rapids Dam downstream to river mile 170 near Hood River, Oregon. In addition, samples were taken from the Yakima and Walla Walla Rivers, and two samples were taken from the Snake River near the Columbia River confluence. During this special study, samples were analyzed for various radionuclides, metals, organics, grain size distribution and

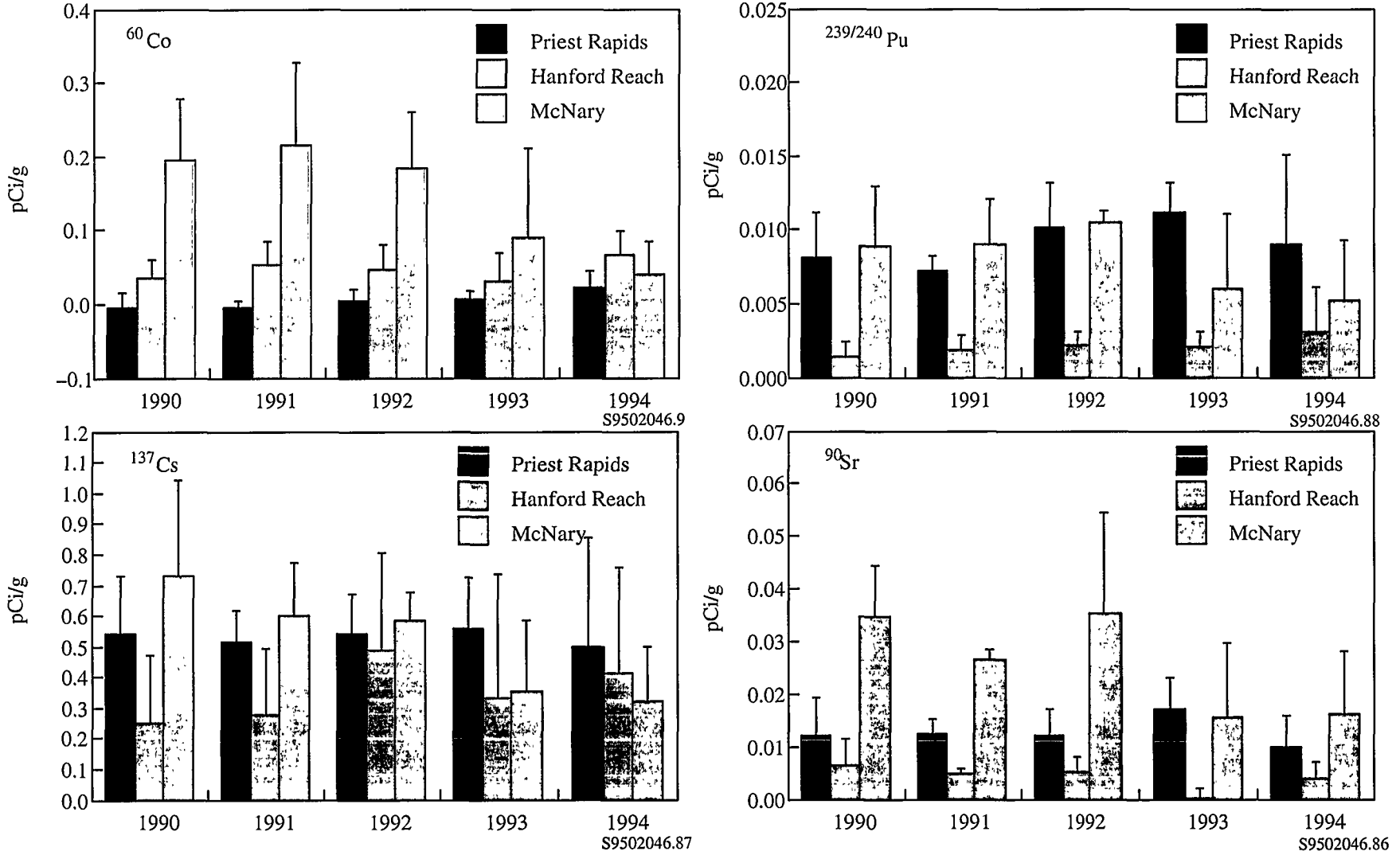

Figure 5.3.12 Regional Mean Radionuclide Concentrations for Cobalt-60, Cesium-137, Plutonium-239/240, and Strontium-90 Occuring in Columbia River Sediments at Priest Rapids Dam, Hanford Reach, and McNary Dam, 1989–1994. Error bars are ±2 standard error of the mean. Regional mean concentrations for Priest Rapids and McNary Dams are an average of four transects. The Hanford Reach regional mean is an average of four different sampling stations (100-F, White Bluffs, Hanford Slough, and Richland Pumphouse).

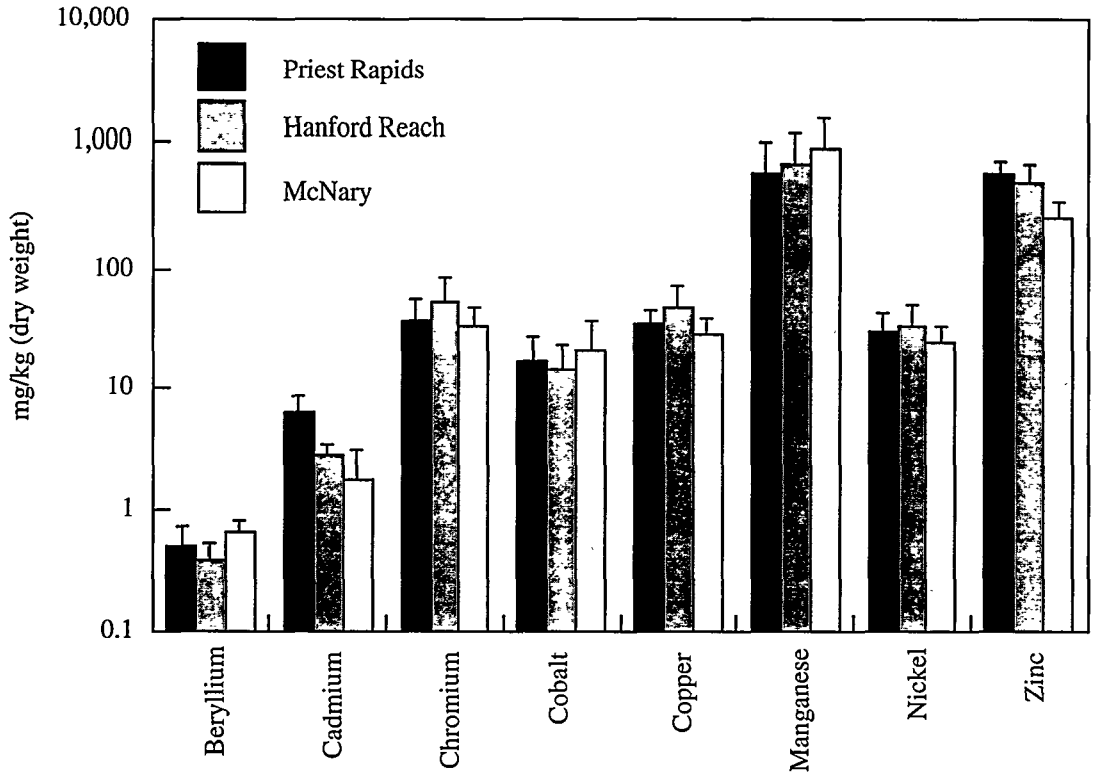

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Figure 5.3.13 Regional Mean Sediment Concentrations for Surface Environmental Surveillance Project 1994 Monitoring Data. Error bars represent ±2 standard error of the mean. Regional mean concentrations for Priest Rapids and McNary Dams are an average of four transects. The Hanford Reach regional mean is an average of four different sampling stations (100-F, White Bluffs, Hanford Slough, and Richland Pumphouse).

total organic carbon content. A Columbia River Comprehensive Impact Assessment Program report documenting the findings from this study is in preparation; selected data results for radionuclides and metals are provided in Appendix A, Table A.8. The organic and chemical (CPAHs, pesticides, etc.) results for this study were very low at all sites sampled, and most concentrations were below the minimum detection limit. A table containing analytical organic data results is presented in Appendix A, Table A.9. In general, concentrations of radionuclides and metals in Columbia River sediment obtained in this study are similar to those previously reported by the Surface Environmental Surveillance Project monitoring program.

Washington Department of Health, Special Report on Sediments in the Columbia River

In March 1994, DOH issued a special report that evaluated radioactivity in Columbia River sediments and their associated health effects (Wells 1994). In that report, dose estimates were made for the maximally exposed individual using maximum measured concentrations of artificial radioactivity in surface sediments of the Columbia River. The report calculated doses from surface and buried sediments in addition to other scenarios. In the DOH report, the maximally exposed individual dose was reported to be 0.13 mrem/yr for surface sediments, which is less than 1% of the natural background

exposure dose. From this dose assessment study, DOH concluded that "calculated doses and attendant risks (to humans) from exposure to artificial radioactivity in Columbia River sediments are small for every section of the river." The concentration of radionuclides used in the DOH dose calculations were higher than the concentrations measured by PNL in 1994, at times by orders of magnitude. The 1994 PNL monitoring results support the DOH conclusions that radionuclide concentrations in Columbia River sediments are low and are not a public health concern.

CH2M HILL Special Study: Chromium in Interstitial Pore Water, Effects on Salmon Redds

During 1994, CH2M HILL conducted a strategic planning assessment for an experimental design to investigate the potential impacts in salmon redds from chromium-contaminated groundwater upwelling along the Hanford Reach. Data collection and analysis is scheduled for 1995. A report documenting the results of this study is in preparation.

Riverbank Springs

The Columbia River is the primary discharge area for the unconfined aquifer underlying the Hanford Site (Dirkes et al. 1994). Ground water thus provides a means for transporting Hanford-associated contaminants, which have leached into ground water from past waste disposal practices, to the Columbia River. Contaminated ground water enters the Columbia River via surface and subsurface discharge. Discharge zones located above the water level of the river are identified in this report as riverbank springs. Routine monitoring of riverbank springs offers the opportunity to characterize the quality of ground water being discharged to the river and to assess the potential human and ecological risk associated with the spring water.

Riverbank springs discharges were documented along the Hanford Reach long before the start-up of Hanford operations (Jenkins 1922). These relatively small springs flow intermittently and are influenced primarily by changes in the river level. Hanford-origin contaminants associated with these ground-water discharges have been documented to enter the river along the Hanford Reach (Dirkes 1990, DOE 1992c, McCormack and Carlile 1984, Peterson 1992).

Sample Collection and Analysis

Routine riverbank springs sampling began in 1988 at the 100-N Area, the old Hanford Townsite, and the 300-Area. In 1993, the monitoring plan was expanded to include the 100-B, 100-K, 100-D, and 100-H Areas. The 100-F Area spring was added in 1994. The locations of all riverbank springs sampled in 1994 are identified in Figure 5.3.1.

From 1988 through 1992, riverbank springs sampling was conducted annually during the period of low river flow (August through September). After 1992, sampling frequency was increased to twice during the low river flow season. Sample collection methods are described in the *Environmental Monitoring Plan* (DOE 1994c).

Sample analyses were selected based on findings of previous riverbank springs investigations, reviews of contaminant concentrations observed in nearby groundwater monitoring wells, and results of preliminary risk assessments. At a minimum, riverbank springs samples collected during 1994 were analyzed for gamma-emitting radionuclides, strontium-90, technetium-99, total alpha, total beta, tritium, uranium-234, -235, and -238. Iodine-129 analysis was included for locations where iodine-129 was known to exist in the ground water as a result of past Hanford operations. Riverbank springs were also analyzed for various nonradiological contaminants including metals, anions, and volatile organic compounds. All analyses were conducted on unfiltered samples.

Results for Riverbank Springs

Hanford-origin contaminants continued to be detected in riverbank spring water entering the Columbia River along the Hanford Site during 1994. The locations and extent of contaminated discharges were consistent with recent ground-water surveys. Aluminum, chromium, iron, manganese, NO_3, strontium-90, TCE (trichloroethylene), technetium-99, tritium, uranium-234, and -238 were found to be entering the river along the 100 Area shoreline. Aluminum, iodine-129, iron, manganese NO_3, technetium-99, and tritium entered the river along the portion of shoreline extending from the old Hanford Townsite to below the 300 Area. Chromium, uranium-234, and -238 were discharged to the river

along the 300 Area shoreline in addition to the other contaminants. The contaminant concentrations in spring water are typically similar but lower than those found in near-shore ground-water wells. Dilution of ground-water discharge may occur when the ground water mixes with river water that has entered the riverbank previously during high river flow (Dresel et al. 1994).

The results of radiological and chemical analyses conducted on riverbank springs samples in 1994 are documented by Bisping (1995). Radiological results are summarized in Appendix A, Table A.10. In the following discussion, radiological and nonradiological results are addressed separately. Contaminant concentration trends are illustrated for locations for which more than 3 years of data are available.

Radiological Results

All radiological contaminant concentrations measured in riverbank springs in 1994 were less than applicable DOE Derived Concentration Guides (Appendix C, Table C.6.). However, strontium-90 in the 100-D and 100-H Areas, tritium in the 100-N Area and along the old Hanford Townsite, and total alpha in the 300 Area exceeded the Washington State and federal Drinking Water Standards (Appendix C, Table C.2.). Total uranium exceeded the Site-specific proposed EPA Drinking Water Standard in the 300 Area. All other radionuclide concentrations were less than applicable Drinking Water Standards.

Table 5.3.3 provides selected radionuclide concentrations measured in water collected from the shoreline near the 100-N Area from 1989 through 1994. The Near-Facility Environmental Monitoring Program has historically sampled the 100-N Area riverbank seepage from the 199-N-8T monitoring well, which is located close to the river (see Figure 3.2.4). This well was also sampled annually by the Surface Environmental Surveillance Project from 1988 through 1991. In 1992, the Surface Environmental Surveillance Project sample was collected from well 199-N-46 (cassion), which is located slightly inland from well 199-N-8T. The concentrations of some contaminants were significantly different in water collected from well 199-N-46 than from water collected previously from well 199-N-8T. The differences were likely a result of the location of well 199-N-46 relative to well 199-N-8T and differences in sampling protocols. In 1993 and 1994, the Surface Environmental Surveillance Project 100-N Area spring samples were collected from actual ground-water seepage entering the river along the shoreline. Sampling in this manner is consistent with the Surface Environmental Surveillance Project sampling protocol at other riverbank spring locations and avoids duplicating efforts of the Near-Facility Environmental Monitoring Program.

Table 5.3.3 Selected Radionuclide Concentrations in 100-N Riverbank Spring Water During the Years 1989 through 1994. Concentrations are ±2 total propagated analytical uncertainty.

Year	Concentration, pCi/L		
	^{3}H	Total Beta	^{90}Sr
1989[a]	37,100 ± 2,870	10,700 ± 726	6,490 ± 1,240
1990[a]	38,500 ± 2,950	8,520 ± 603	3,990 ± 734
1991[a]	11,300 ± 1,040	7,140 ± 574	5,110 ± 1,000
1992[b]	4,870 ± 501	24,100 ± 1,730	10,900 ± 2,020
1993[c]			
Min	28,500 ± 2,220	2.41 ± 3.17	-0.0104 ± 0.221
Max	28,900 ± 2,260	4.50 ± 3.32	0.0204 ± 0.256
1994[c]	30,900 ± 2,380	8.79 ± 2.26	0.129 ± 0.107

(a) Samples collected from well 199-N-8T (see Figure 3.2.4).
(b) Sample collected from well 199-N-46 (see Figure 3.2.4).
(c) Sample collected from shoreline spring 0.9 km downstream of well 199-N-8T.

During 1993 and 1994, there was no visible groundwater seepage present directly adjacent to well 199-N-8T during sampling. The 100-N Area spring samples were taken from the nearest downstream riverbank spring located approximately 0.9 km (0.5 mi) from the well. As a result of the proximity of the riverbank spring to the contaminant plumes emanating from the 100-N Area, some contaminant concentrations measured in the spring water were significantly different from those previously measured in either of the two wells (see Table 5.3.3). The spring is located closer to the centerline of the tritium plume and farther from the centerline of the strontium-90 plume than were either of the two wells. The lower total beta concentrations in spring water, relative to those in well water, most likely result from lower strontium-90 levels. Technetium-99 and total uranium were the only other measured contaminants whose concentrations exceeded the 2 total propagated analytical uncertainty. The technetium-99 concentration was 0.3% of the Drinking Water Standard. The total uranium concentration was 18% of the Site-specific proposed EPA Drinking Water Standard.

Concentrations of radionuclides of concern in the riverbank spring near the old Hanford Townsite for 1989 through 1994 are provided in Figure 5.3.14. Total beta and technetium-99 concentrations in 1994 were lower than those observed during recent years. Tritium concentrations exhibited a wide fluctuation; the highest concentration was within the range normally observed. The lower contaminant concentrations may result from dilution of groundwater discharge by river water that entered the riverbank during higher flows. The concentrations of all three contaminants were lowest in early September when the river flow was lower than it had been throughout the previous week. With the exception of total uranium, all other measured contaminant concentrations rarely rose above their associated 2 total propagated analytical uncertainty. Total uranium concentrations were less than 30% of the Site-specific proposed EPA Drinking Water Standard. The iodine-129 concentration measured in the old Hanford Townsite riverbank spring (0.0435 ± 0.347 pCi/L) was less than 5% of the Drinking Water Standard.

Figure 5.3.15 depicts the concentrations of constituents of concern in the 300 Area riverbank spring

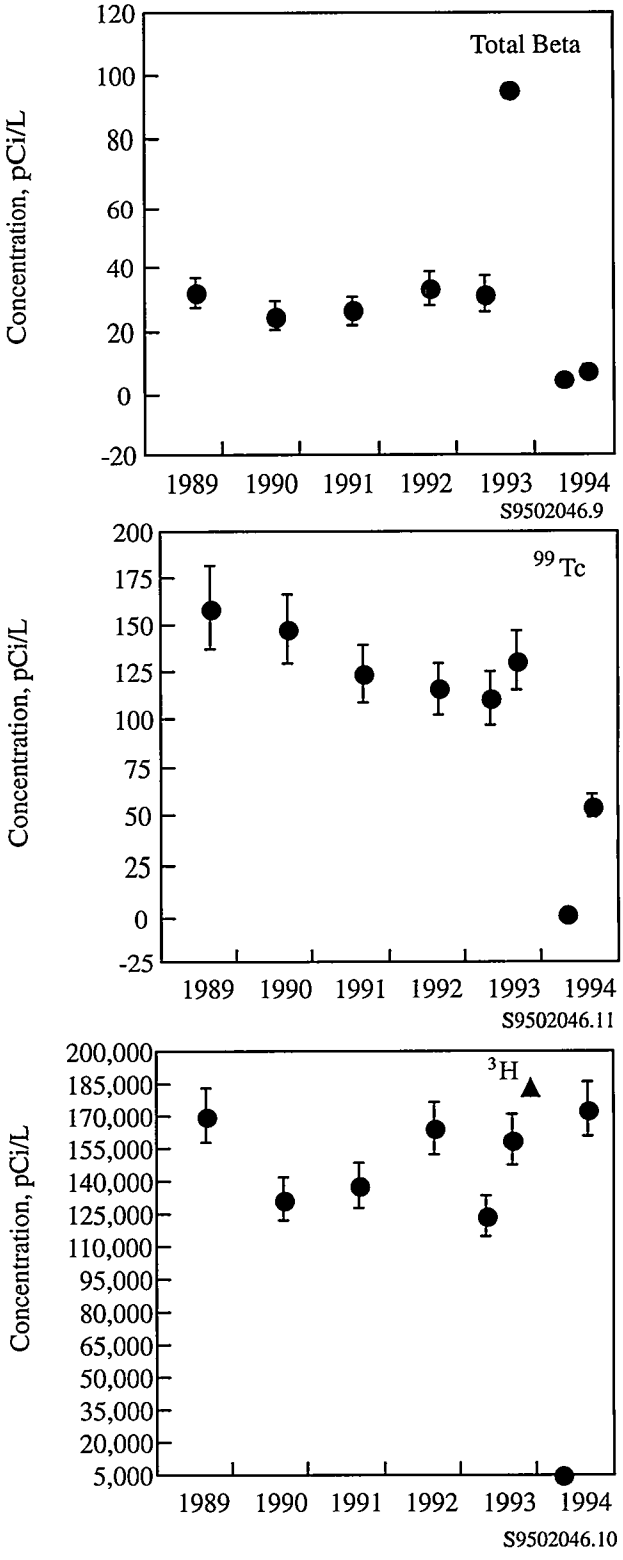


Figure 5.3.14 Constituents of Concern in the Riverbank Spring near the old Hanford Townsite, 1989 Through 1994. As a result of figure scale, some uncertainties (error bars) are concealed by point symbol.

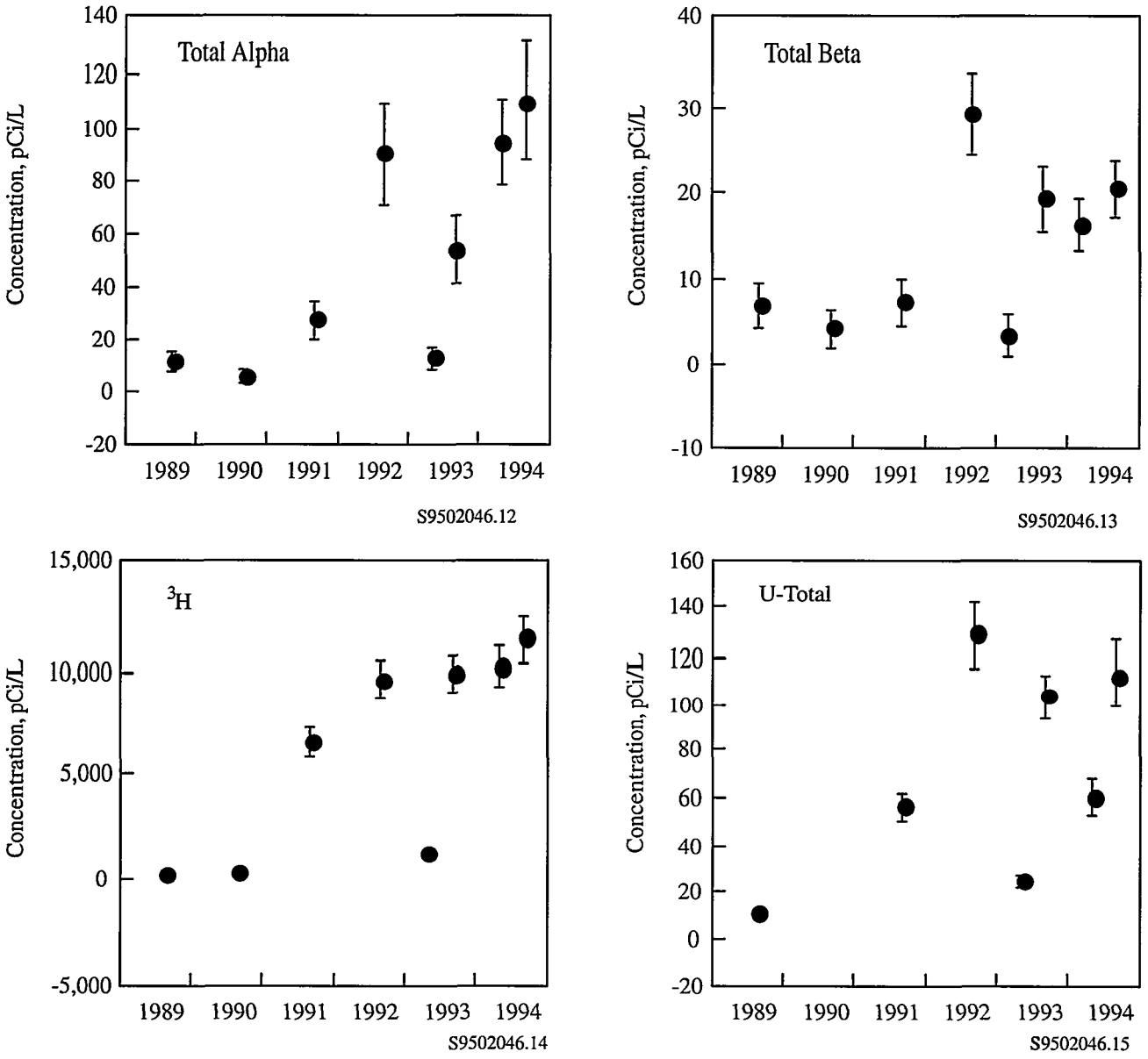


Figure 5.3.15 Constituents of Concern in the 300 Area Riverbank Spring, 1989 Through 1994. As a result of figure scale, some uncertainties (error bars) are concealed by point symbol.

from 1989 through 1994. Elevated contaminant concentrations during 1992 are believed to result from control of the river water level by special arrangement during the 1992 riverbank spring sampling activities. These activities maximized the contribution of ground water in the springs and minimized the bank storage effect. The rising trend in tritium concentrations measured in the 300 Area riverbank spring during the past 4 years reflects the expansion of the contaminated ground-water plume emanating from the 200 Areas. This plume has expanded into the 300 Area during recent years (Dirkes 1993). Total uranium concentrations discharged to the Columbia River in the 300 Area have also increased in recent years as the plume originating from the Liquid Waste Disposal Facilities moved farther toward the river. Total alpha and total beta concentration trends parallel that of uranium and are likely associated with its presence. With the exception of technetium-99 and iodine-129, whose concentrations were less than 2% and 0.5% of the Drinking Water Standard, respectively, the concentrations of all other measured contaminants in the 300 Area spring were generally

lower than their associated 2 total propagated analytical uncertainty.

The concentrations of measured contaminants in 100-B, 100-D, 100-F, and 100-H Area riverbank springs are listed in Bisping (1995). In each of these 100 Areas springs, technetium-99, tritium, uranium-234, and -238 were the only constituents consistently found in concentrations greater than the 2 total propagated analytical uncertainty. Technetium-99 concentrations were less than 5% of the Drinking Water Standard. Total uranium concentrations were less than 15% of the Site-specific proposed EPA Drinking Water Standard. Tritium concentrations varied widely with location, ranging from less than 6% of the Drinking Water Standard in the 100-F and 100-H Area springs to approximately 75% in the 100-B Area spring. Measurable levels of strontium-90 were found only in the 100-D Area spring.

Nonradiological Results

All nonradiological contaminant concentrations measured in riverbank springs located on the Hanford shoreline in 1994 were below the primary Washington State and EPA Drinking Water Standards (Appendix C, Table C.3.), with the exceptions of chromium and NO_3 in the 100-D Area spring. Chromium and NO_3 concentrations in 100-D Area ground water are commonly found to exceed Drinking Water Standards as a result of past Hanford operations (Dresel et al. 1994). Iron in the 300 Area and aluminum, iron, and manganese in the 100-N Area and along the old Hanford Townsite exceeded the secondary Washington State and EPA Drinking Water Standards in 1994 riverbank springs samples. Secondary Drinking Water Standards are based on factors other than health effects. (Appendix C, Table C.3.)

Onsite Ponds

Three onsite ponds (see Figure 5.3.1) located near operational areas were sampled periodically during 1994. The B Pond, located near the 200-East Area, was excavated in the mid-1950s and expanded in the 1980s for disposal of process cooling water and other liquid wastes that occasionally contained low levels of radionuclides. West Lake, located north of the 200-East Area, is recharged from ground water (Gephart et al. 1976) and has not received direct effluent discharges from Site facilities. The FFTF Pond, located near the 400 Area, was excavated in 1978 for the disposal of cooling and sanitary water from various facilities in the 400 Area.

The Site Operations and Engineering contractor is responsible for monitoring effluents discharged to the ponds and for operational surveillance of the ponds. Although the ponds were inaccessible to the public and did not constitute a direct offsite environmental impact during 1994, they were accessible to migratory waterfowl, creating a potential biological pathway for the dispersion of contaminants (see Section 5.5, "Wildlife Surveillance"). Periodic sampling of the ponds also provided an independent check on effluent control and monitoring systems.

Sample Collection and Analysis

In 1994, grab samples were collected quarterly from B Pond, FFTF Pond and West Lake. Unfiltered aliquots of all samples were analyzed for total alpha and total beta activities, gamma-emitting radionuclides, and tritium. Samples from B Pond were also analyzed for strontium-90 and technetium-99. West Lake samples were also analyzed for strontium-90, technetium-99, uranium-234, -235, and -238. Constituents were chosen for analysis based on their known presence in local ground water and in effluents discharged to the ponds and their potential to contribute to the overall radiation dose delivered to the public.

Results

Analytical results from pond samples collected during 1994 are listed by Bisping (1995). Although the pond water is not used for human consumption, Drinking Water Standards and DOE Derived Concentration Guides provide useful reference concentrations to characterize the pond water quality. With the exception of uranium-234 and -238 in the July sample of West Lake, radionuclide concentrations in onsite pond water were less than applicable Derived Concentration Guides (Appendix C, Table C.6.). The Washington State and EPA Drinking Water Standard (Appendix C, Table C.2.) for total alpha was exceeded in all West Lake samples and in the July sample of B Pond. The Site-specific proposed EPA Drinking Water Standard for uranium was also exceeded in West Lake. The concentration

of all other radionuclides were less than applicable Drinking Water Standards.

Annual concentrations of select radionuclides in B Pond for the years 1989 through 1994 are shown in Figure 5.3.16. Elevated total alpha and total beta results were observed in the July 1994 sample from B Pond. Median concentrations, however, remained within the ranges of previously reported results. Tritium and strontium-90 levels were less than 0.5% and 9% of their respective Drinking Water Standards in 1994 and were within the range observed during the previous 5 years. All other measured contaminant concentrations were less than 20% of applicable Drinking Water Standards and rarely rose above their associated 2 total propagated analytical uncertainty. The B Pond was decommissioned in the summer of 1994. The October 1994 sample was collected from the B Pond Extension. Contaminant concentrations in the B Pond Extension were similar to those found in B Pond itself earlier in the year.

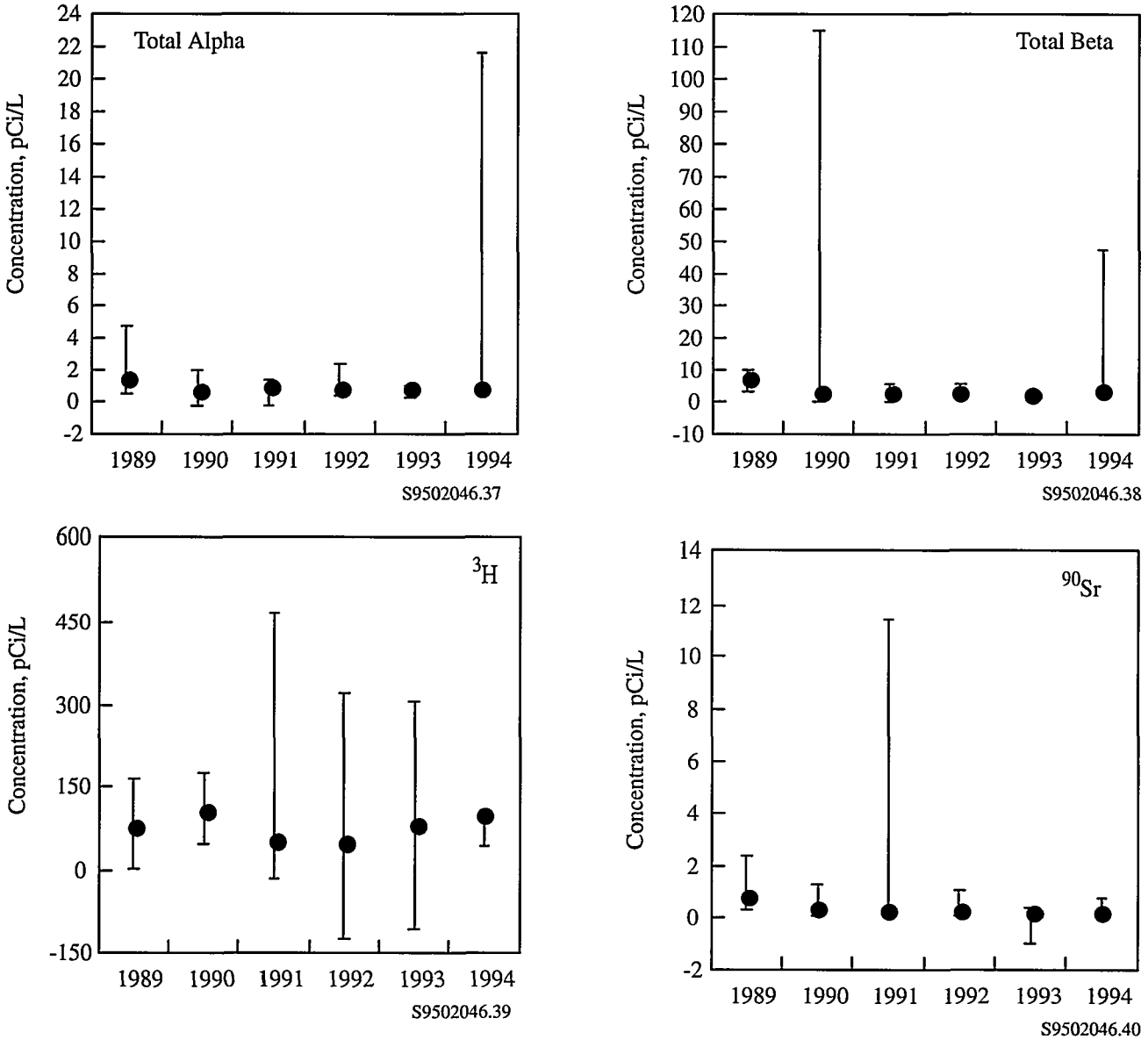


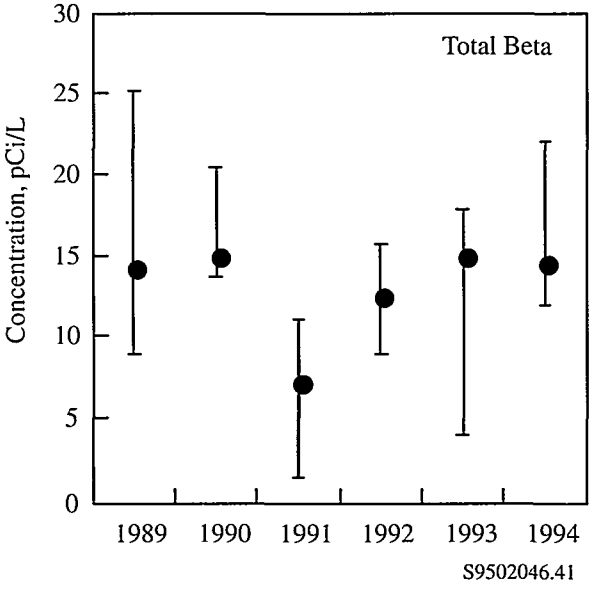
Figure 5.3.16 Minimum, Median, and Maximum Concentrations of Selected Radionuclides in B Pond, 1989 Through 1994. As a result of figure scale, some maximum and minimum values are concealed by point symbol.

Figure 5.3.17 shows the annual total beta and tritium concentrations in FFTF Pond from 1989 through 1994. The concentrations of both constituents have remained stable in recent years. Tritium concentrations observed in FFTF Pond in 1994 were less than 35% of the Drinking Water Standard, lower than those commonly observed in the local unconfined aquifer. The concentrations of all other measured contaminants in FFTF Pond rarely exceeded their respective 2 total propagated analytical uncertainties.

The 1989 through 1994 annual concentrations of select radionuclides in West Lake are shown in Figure 5.3.18. Median total alpha and total beta concentrations during 1994 were similar to those observed in the past. Total alpha and total beta concentrations in West Lake continued to be higher than the alpha and beta levels found in the other onsite ponds. These elevated levels are believed to result from high concentrations of naturally occurring uranium (Poston et al. 1991, Speer et al. 1976). Annual median total uranium concentrations have remained stable over the last 6 years. The range in concentration, however, has shown a dramatic increase. Both the minimum and maximum annual total uranium concentrations have risen in recent years; the highest concentration occurred in summer and fall when the water level in the pond was low. It is believed that relatively large concentrations of suspended sediment in the samples is causing the elevated results. Ground water level declines in the 200 Areas have been recorded since the decommissioning of U Pond in 1984 and the shutdown of production facilities (Dresel et al. 1994). As a result, the water level in West Lake has dropped, and the pond was dry when sampling was attempted in the fall of 1994. Low water levels increase the likelihood of collecting samples that contain newly suspended sediment disturbed during the sampling process. Similar total uranium concentrations were reported by Poston et al. (1991) for West Lake samples that contained high concentrations of suspended sediment. Strontium-90 and tritium concentrations found in West Lake in 1994 were within the range observed during the previous 5 years and reflect local ground-water concentrations. With the exception of technetium-99, whose concentrations were less than 8% of the Drinking Water Standard, the concentrations of all other measured contaminants were generally lower than their associated 2 total propagated analytical uncertainties.

Offsite Water

During 1994, water samples were collected from four water systems directly east of and across the Columbia River from the Hanford Site. Samples were also collected from an irrigation canal downstream from Hanford that obtains water pumped from the Columbia River. As a result of



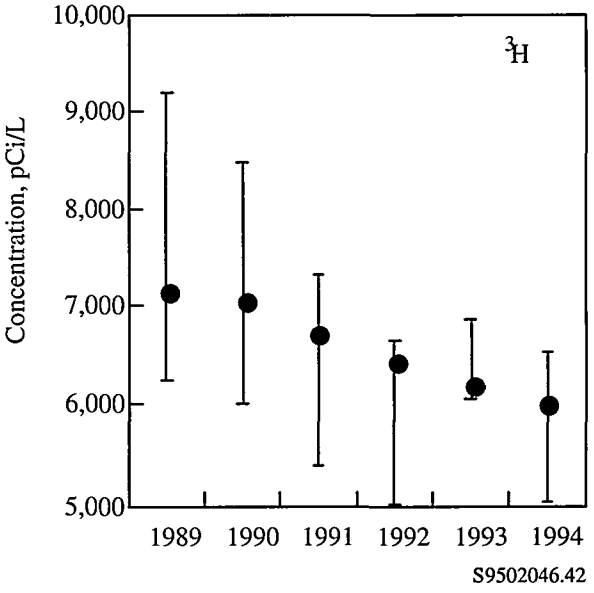


Figure 5.3.17 Minimum, Median, and Maximum Total Beta and Tritium Concentrations in FFTF Pond, 1989 Through 1994

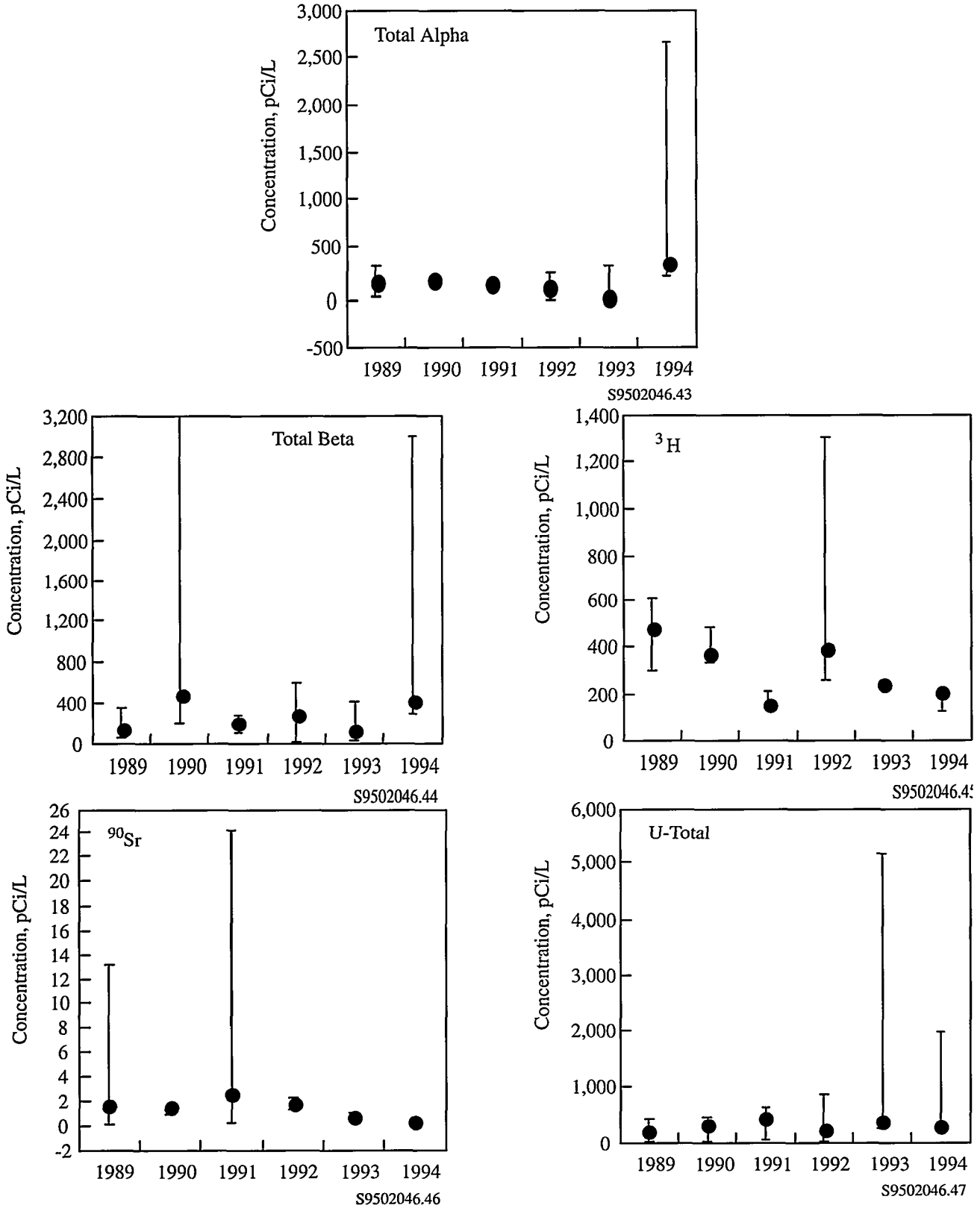


Figure 5.3.18 Minimum, Median, and Maximum Concentrations of Selected Radionuclides in West Lake, 1989 Through 1994. As a result of figure scale, some maximum and minimum values are concealed by point symbol. The maximum total beta concentration in 1990 was 271,000 pCi/L.

public concern about the potential for Hanford-associated contaminants to be present in offsite water, sampling was conducted to document the levels of radionuclides in water used by the public. Consumption of food irrigated with Columbia River water downstream from the Site has been identified as one of the primary pathways contributing to the potential dose to the hypothetical maximally exposed individual (Jaquish and Mitchell 1988).

Sample Collection, Analysis, and Results

Grab samples were collected once from four offsite domestic water supplies during 1994 (see Figure 5.3.1). Analyses of unfiltered aliquots of the samples included gamma scan, total alpha, total beta, tritium, uranium-234, -235, and -238. All radionuclide concentrations measured in offsite water supplies in 1994, and reported by Bisping (1995), were below applicable DOE Derived Concentration Guides (Appendix C, Table C.6) and the Washington State and EPA Drinking Water Standards. The proposed EPA Drinking Water Standard for total uranium, however, was exceeded at Alexander Farm.

Elevated total alpha and beta concentrations measured in offsite water supplies in 1994 were attributable to natural uranium concentrations in the ground water. Uranium was detected at measurable concentrations in all domestic water supplies, with the exception of the deep well of the White Bluffs Water Association. Total uranium concentrations observed in offsite water supplies were comparable to those reported by the state of Washington and were not attributable to Hanford operations. The concentrations of all other measured radionuclides in offsite drinking water during 1994 rarely exceeded their associated 2 total propagated analytical uncertainty.

Water in the Riverview irrigation canal was sampled three times in 1994 during the irrigation season. Unfiltered samples of the canal water were analyzed for gamma emitters, strontium-90, total alpha, total beta, tritium, uranium-234, -235, and -238. Results are presented by Bisping (1995). In 1994, radionuclide concentrations measured in Riverview irrigation water were found to be at the same levels observed in the Columbia River. All radionuclide concentrations were below applicable DOE Derived Concentration Guides and Washington State and EPA Drinking Water Standards. Strontium-90 was the radionuclide of most concern because it has been identified as one of the primary contributors to the calculated hypothetical dose to the public via the water pathway (Jaquish and Bryce 1989). The concentrations of strontium-90 in the irrigation water during 1994 ranged from 0.06 to 0.10 pCi/L and were similar to those reported for the Columbia River at Priest Rapids Dam and the Richland Pumphouse (see Columbia River Water subsection).