5.4 Food and Farm Product Surveillance

T. M. Poston

Alfalfa and a number of foodstuffs including milk, asparagus, wheat, beef, chickens, eggs, vegetables, fruits, and wine were collected at several locations surrounding the Hanford Site (Figure 5.4.1). Samples were collected primarily from locations in the prevailing downwind directions (south and east of the Site) where airborne effluents from Hanford could be expected to be deposited. Samples were also collected in generally upwind directions, on the Site perimeter and at locations somewhat distant from the Site, to provide information on background radioactivity. This section summarizes the radiological analyses performed on samples collected in 1994. Detailed analytical results are listed by Bisping (1995), some of which have been summarized in Appendix A. The potential dose to members of the public from consuming local foods and farm products is addressed in Section 6.0, "Potential Radiation Doses from 1994 Hanford Operations." Results for fruits and vegetables and animal products are reported in pCi/g wet weight. Results for wheat and alfalfa are reported in pCi/g dry weight. Radionuclide concentrations in most samples were less than the limits of detection. Results for tritium (tritium present as water) in milk, wine, and fruits are reported in pCi per liter (pCi/L) of liquid distilled from the food product. Most tritium is found as water, and very little tritium is organically bound to other constituents present in biological material.

The food and farm product sampling design addresses the potential influence of Hanford Site releases in two ways: by comparing results from several downwind locations to those from generally upwind or distant locations, and by comparing results from locations irrigated with Columbia River water withdrawn downstream from Hanford to results from locations irrigated with water from other sources. Specific details of the sampling design including sampling locations and radionuclides analyzed are reported by Bisping (1995) and DOE (1991b) and are summarized in Table 5.4.1. Gamma scans (cesium-137, cobalt-60, and other radionuclides; see Appendix F) and strontium-90 analyses were routinely performed for nearly all products. Selected food products were specifically analyzed for additional radionuclides including iodine-129, plutonium, technetium-99, tritium, and uranium.

One uncontrolled factor influencing concentrations of radionuclides in milk and other dairy products, beef, and poultry is the source of food for the farm animals. Cattle and poultry may be fed with food grown outside of their sampling locations. For radionuclides that are present in fallout from weapons testing, fallout radioactivity in feed may be a significant source of monitored levels in dairy products. Generally, levels of fallout radioactivity in environmental media correlate positively with precipitation.

Milk

Sample Collection and Analysis

Composite samples of raw, whole milk were collected from three East Wahluke and three Sagemoor area dairy farms near the Site perimeter in the prevailingly downwind direction to evaluate possible Hanford impacts (Figure 5.4.1). Milk samples were also collected from a Sunnyside dairy to indicate the general background concentrations of radionuclides at a generally upwind location. Samples were collected monthly throughout the year from the Sagemoor area and quarterly from the other areas.

Milk was analyzed for iodine-129, strontium-90, tritium, and gamma emitters such as cesium-137 because these radionuclides have the potential to move through the air-pasture-cow-milk or water-pasture-cow-milk food chain. Tritium is released into the atmosphere from Site facilities and to the Columbia River via shoreline ground-water springs. Strontium-90 is released into the Columbia River through the N Springs. Iodine-129 has been released to the air from the Hanford Site in the past and is still being released to the Columbia River via the Site ground-water plume. Cesium-137 was present in atmospheric fallout from weapons testing and is found in Site radiological waste. Tritium and gamma analyses were conducted on each monthly

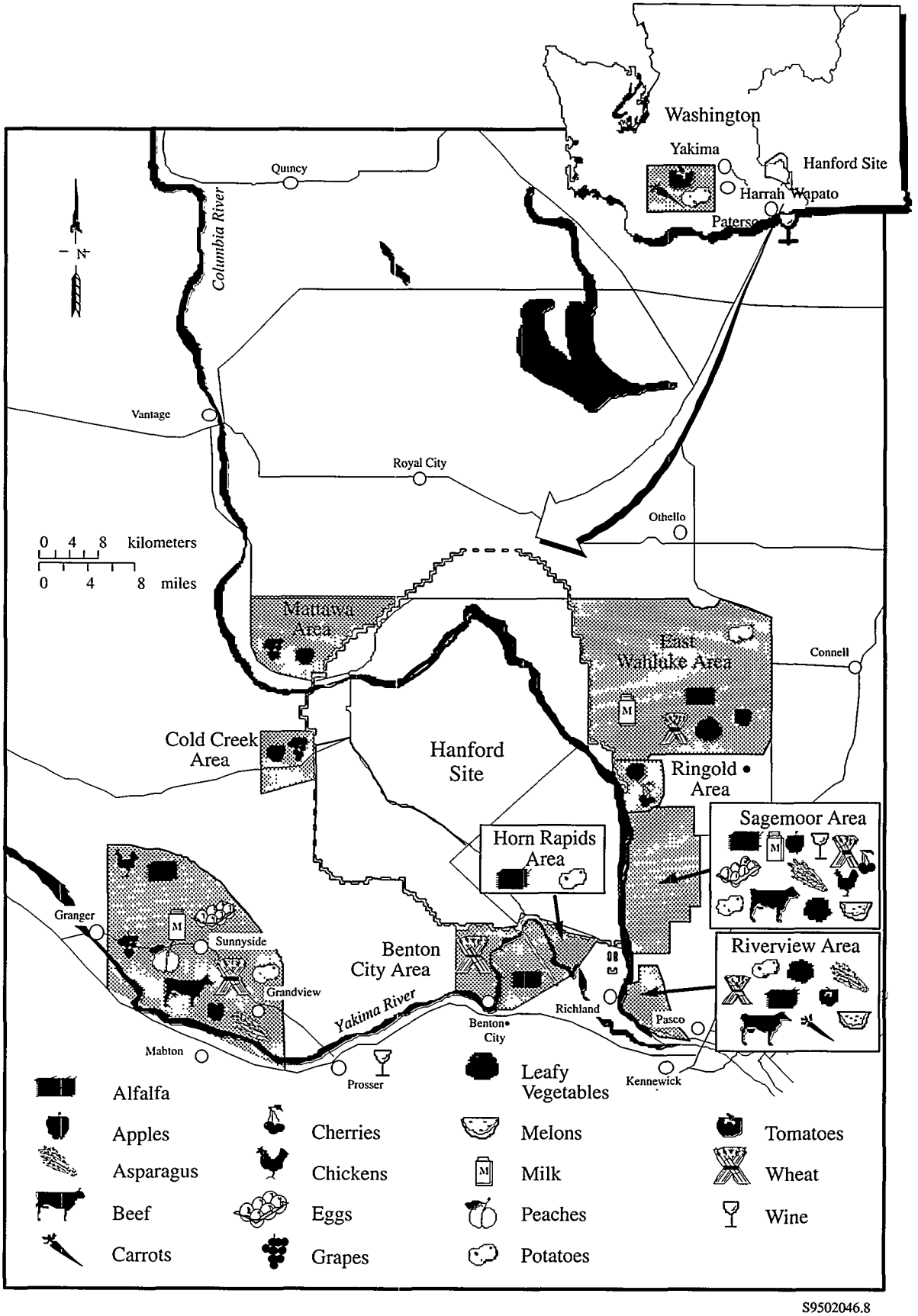

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Figure 5.4.1 Food and Farm Product Sampling Locations, 1994

Table 5.4.1 Numbers of Locations, Sampling Frequencies, and Analyses Performed for Routinely Sampled Food and Farm Products, 1994[a]

Media	Number of Locations		Sampling Frequency[b]	Number of Locations Analyzed						
	Upwind	Downwind		^{3}H	Gamma	^{90}Sr	^{99}Tc	^{129}I	U	Pu
Milk	1	2	M, Q, or SA	3	3	3	0	3	0	0
Eggs, meat, and poultry	1	2	SA or A	0	3	3	0	0	0	0
Vegetables	2	4	A	2	6	6	3	1	2	3
Fruit	2	3	A	5	5	5	0	2	0	3
Wheat and alfalfa	1	4	A	0	5	5	0	0	0	2
Wine	2	1	A	3	3	0	0	0	0	0

(a) Media may include multiple varieties for each category. Not all analytes were assayed at all locations or for each variety of media.
(b) M = monthly; Q = quarterly; SA = semiannually; A = annually.

sample, strontium-90 analyses were conducted on each quarterly sample, and iodine-129 analyses were conducted on two semiannual composite samples (one each from Sagemoor and Sunnyside). Tritium analysis was performed on water distilled from milk, and as a consequence, would slightly overestimate the true concentration of tritium in bulk milk.

Results

Tritium was detected in 1 of the 20 (5%) milk samples analyzed; the maximum concentration was 260 ± 200 pCi/L in a sample collected from the Sagemoor area. While there is no tritium standard for milk, the standard for drinking water is 20,000 pCi/L.

Strontium-90 was measured in six of nine (67%) milk samples analyzed in 1994, with no apparent differences between upwind and downwind locations (Table 5.4.2). Concentrations of strontium-90 have remained near the detection limit (4 pCi/L) and relatively constant over the past 6 years (Figure 5.4.2). The maximum observed concentration of strontium-90 in milk in 1994 was 0.97 ± 0.43 pCi/L. While there is no strontium-90 standard for milk, the standard for drinking water is 8 pCi/L.

Iodine-129 was identified by high-resolution mass spectrometry in seven milk samples tested (Table 5.4.2). In recent years, the levels of iodine-129 in milk collected from generally downwind dairies at Sagemoor and East Wahluke have persisted at levels two to four times greater than levels measured upwind in Sunnyside (Figure 5.4.3). Iodine-129 concentrations have been declining with the end of nuclear production activities onsite. Iodine-129 contributes less than 1% of the dose to the maximally exposed individual (MEI) through the consumption of dairy products (see Section 6.0). The maximum observed concentration of iodine-129 in milk in 1994 was 0.0008 ± 0.0002 pCi/L. While there is no iodine-129 standard for milk, the standard for drinking water is 1 pCi/L.

Three of the 21 (14%) milk samples collected and analyzed for cesium-137 in 1994 contained detectable concentrations (>4.0 pCi/L). There was no apparent difference between results upwind and downwind of the Site. The maximum observed concentration of cesium-137 in milk in 1994 was 3.1 ± 2.6 pCi/L. While there is no cesium-137 standard for milk, the standard for drinking water is 200 pCi/L. No other gamma emitters were consistently detectable (Bisping 1995).

Table 5.4.2 Radionuclide Concentrations in Milk (pCi/L), 1994 Compared to Values from the Previous 5 Years

		1994[a]		
	Location	Maximum[b]	Mean[c]	No. Less Than Detection[d]
^{90}Sr				
Downwind	Wahluke Area	0.97 ± 0.43	0.82 ± 0.19	1 of 3
	Sagemoor	0.45 ± 0.38	0.40 ± 0.06	1 of 3
Upwind	Sunnyside	0.84 ± 0.73	0.622 ± 0.39	1 of 3
^{129}I				
Downwind	Wahluke Area	0.0008 ± 0.00017	0.0006 ± 0.00020	0 of 2
	Sagemoor	0.0008 ± 0.00019	0.0007 ± 0.00018	0 of 2
Upwind	Sunnyside	0.0004 ± 0.00004	0.0004 ± 0.00004	0 of 2

		1989-1993[a]		
	Location	Maximum[b]	Mean[c]	No. Less Than Detection[d]
^{90}Sr				
Downwind	Wahluke Area	1.8 ± 0.98	0.71 ± 0.17	4 of 20
	Sagemoor	1.2 ± 0.44	0.63 ± 0.12	3 of 20
Upwind	Sunnyside	3.2 ± 1.20	0.65 ± 0.31	4 of 20
^{129}I				
Downwind	Wahluke Area	0.0041 ± 0.00031	0.0014 ± 0.0007	0 of 9
	Sagemoor	0.0125 ± 0.0016	0.0027 ± 0.0025	0 of 9
Upwind	Sunnyside	0.0032 ± 0.00020	0.0007 ± 0.0006	0 of 9

(a) Results have shown a decreasing trend over the period of 1989 to 1994.
(b) Maximum ±2 total propagated analytical uncertainty.
(c) Mean ±2 standard error of the calculated mean, expressed as a percentage.
(d) Number of samples with values less than the ±2 total propagated analytical uncertainty out of number of samples analyzed. Means are based on all sample results.

Beef, Chickens, and Eggs

Sample Collection and Analysis

Samples of locally produced poultry and eggs were collected twice annually from areas adjacent to the Hanford Site (Sagemoor and Sunnyside, Figure 5.4.1) and analyzed for strontium-90 and gamma emitters such as cesium-137. Beef was collected once in 1994 from the Sagemoor, Riverview, and Sunnyside areas for analysis of strontium-90 and gamma emitters such as cesium-137. Strontium-90 is monitored because it is released into the Columbia River through the N Springs. Cesium-137 is monitored because it is present in Site wastes. Both radionuclides have the potential to move through the food chain to beef, chickens, and eggs.

Results

In 1994, strontium-90 was measured in shells in half the egg samples collected at each location. The maximum concentration was 0.22 ± 0.06 pCi/g in a shell sample from Sagemoor. Strontium-90 was not detected in the edible portion of the eggs

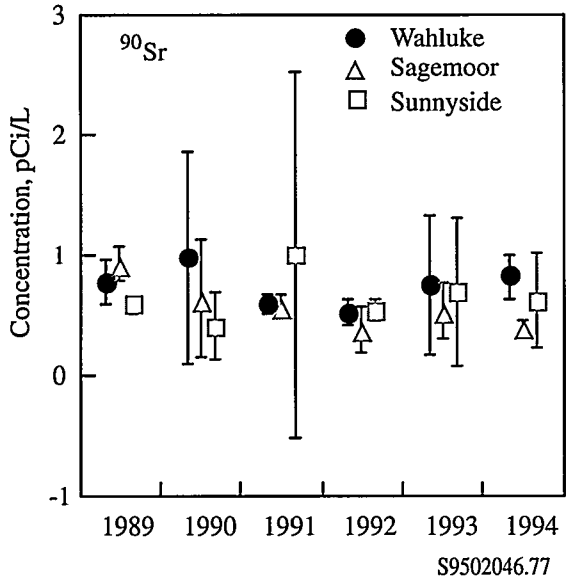

Figure 5.4.2 Mean (±2 standard error of the mean) Strontium-90 Concentrations in Milk, 1989 Through 1994. As a result of figure scale, some uncertainties are concealed by point symbol.

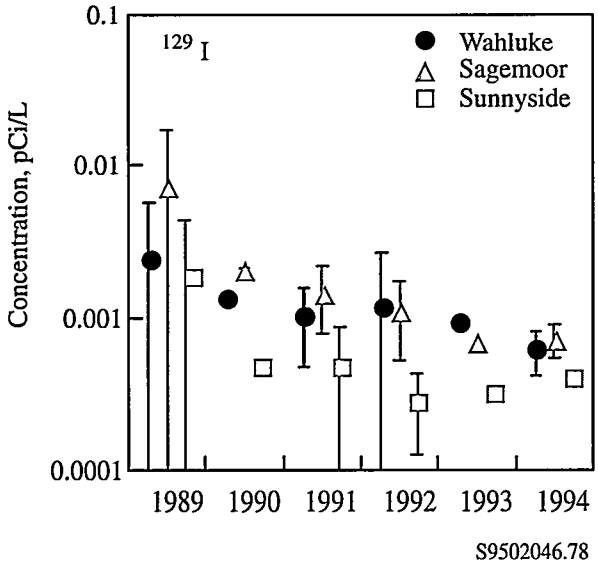

Figure 5.4.3 Mean (±2 standard error of the mean) Iodine-129 Concentrations in Milk, 1989 Through 1994. As a result of figure scale, some uncertainties are concealed by point symbol.

collected in 1994, nor has it been detected in earlier samplings of the edible portion (Dirkes et al. 1994). Strontium-90 has been previously monitored in Canada goose egg shells as an indicator of environmental contamination (Poston 1994); however, this is the first year that chicken egg shells have been analyzed. No measurable concentrations of any manmade gamma emitter, such as cesium-137, were found in chicken or egg samples.

In 1994, manmade radionuclides were not detected in samples of locally produced beef.

Vegetables

Sample Collection and Analysis

Samples of leafy vegetables (cabbage, broccoli leaves, beet tops, or turnip greens), asparagus, tomatoes, carrots, and potatoes were obtained during the summer from gardens and farms located within the sampling areas (see Figure 5.4.1). In conjunction with DOH, carrots were also sampled from Harrah, a farming community about 13 km (8 mi) south of Yakima and upwind of the Hanford Site. Samples were collected from the Riverview and Horn Rapids areas to assess potential contamination from crop irrigation at those locations. Irrigation water for Horn Rapids and Riverview is withdrawn from the Columbia River downstream from Hanford.

Leafy vegetables are sampled because of the potential deposition of airborne contaminants, and at some locations, deposition from overhead irrigation. Leafy vegetables were provided by the Bailie Memorial Youth Ranch in the East Wahluke sampling area and Country Haven Academy in the Sagemoor Area. All vegetable samples were analyzed for gamma-emitting radionuclides and strontium-90; in addition, tomatoes from selected locations were analyzed for tritium, and potatoes from selected locations were analyzed for plutonium-238, plutonium-239,240, technetium-99, and uranium isotopes. Tritium is monitored because it has been released into the atmosphere from Site facilities and to the Columbia River via shoreline ground-water springs. Strontium-90 is monitored because it is released into the Columbia River at the N Springs and is known to accumulate in some plants. Technetium-99 is monitored because it is known to enter the Columbia River through shoreline seeps and springs, has a long half-life, and can accumulate in farm products that may be irrigated with Columbia River water withdrawn downstream from Hanford. Iodine-129 is monitored because it can move through the air-vegetation-human food chain. Cesium-137 is monitored because it is present in Hanford wastes and atmospheric fallout from

weapons testing. Isotopes of uranium are monitored because they enter the Columbia River in springs near the 300 Area and are known to accumulate in soil and vegetation. Plutonium-238 and plutonium-239,240 are monitored because of past releases and to assure the public that concentrations of plutonium isotopes are not a concern in vegetables.

Results

Many of the analytical results for vegetables were below the detection limits for specific radionuclides. For leafy vegetable samples in 1994, the only radionuclide measured above the detection limit was strontium-90. The Riverview sample (0.030 ± 0.007 pCi/g) and Sagemoor sample (0.025 ± 0.007 pCi/g) exceeded the detection limit of 0.005 pCi/g. For tomato samples in 1994, no manmade radionuclides were detected above the detection limit.

Carrots and potatoes were also sampled at several locations around Hanford. The only radionuclide measured was strontium-90 (0.005 ± 0.004 pCi/g), at the detection limit. Measurements of gamma emitters, plutonium-238, plutonium-239,240, technetium-99, and uranium isotopes were all less than their respective detection limits.

A special sampling of asparagus was conducted in 1994 at Riverview, Sagemoor, and Sunnyside. The only radionuclide found in asparagus was strontium-90 in samples collected from all three locations. Concentrations were at the detection limit of 0.005 pCi/g. The only location with concentrations of uranium above the detection limit was Riverview (0.009 ± 0.004 pCi/g uranium-238). A more extensive study of uranium in asparagus conducted in 1990 (Tiller and Poston 1992) concluded that there was no difference between wild asparagus collected onsite and harvested asparagus collected offsite. The Riverview site was not sampled in that study; however, the Sagemoor site had the highest concentrations of uranium-238 in 1990.

Fruit

Sample Collection and Analysis

Samples of apples, peaches (Sunnyside only), cherries, concord grapes, and melons were collected before or during harvest from the areas shown in Figure 5.4.1 (not all types were collected in each area). The edible portions were analyzed for gamma emitters, strontium-90, tritium, and for selected samples, iodine-129 and plutonium-239,240. Tritium was analyzed in the distillate collected from fruit samples.

Results

With one exception, measurable levels of manmade radioactivity were not detected in apples, peaches, cherries, concord grapes, or melons collected in 1994 from either upwind or downwind locations. The exception was strontium-90 in a melon sample from Riverview (0.008 ± 0.004 pCi/g). These results are consistent with fruit measurements over recent years (Bisping and Woodruff 1990, 1991, 1992, 1993; Bisping 1994b). Minimum levels of detection were 0.02 pCi/g wet weight for cesium-137, 1 pCi/g wet weight for iodine-129, 0.0004 pCi/g wet weight for plutonium-239,240, 0.005 pCi/g wet weight for strontium-90, and 300 pCi/L plant distillate for tritium.

Wine

Sample Collection and Analysis

Locally produced red and white wines (1994 vintage grapes) were analyzed for tritium and gamma-emitting radionuclides . The wines were made from grapes grown at individual vineyards in the Sagemoor Area downwind of the Site, and at two upwind locations, one at Prosser and one at Patterson. Three samples of each wine were obtained from each area. Wine samples collected in 1993 were also subjected to a very sensitive mass spectrometry analysis for tritium that is roughly 15 times more sensitive than the distillation method routinely used for wine analysis (Surano et al. 1992). The DOH performed tritium analysis on wine distilates in

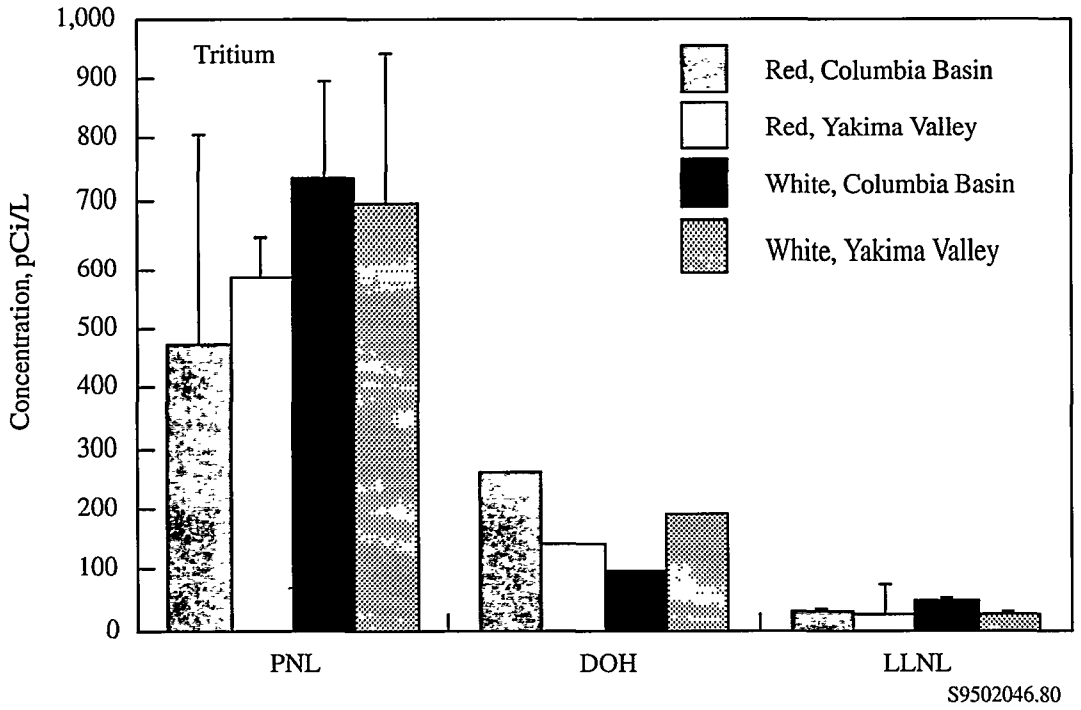

Figure 5.4.4 Comparison of Tritium Concentrations in Replicate Samples of Four Varieties of 1993 Wine Analyzed by PNL, DOH, and LLNL

1993. These 1993 data are summarized in this report.

Results

Gamma spectroscopy of wine samples did not indicate the presence of cesium-137 or cobalt-60 in any of the samples. The minimum detectable concentrations (MDCs) for cesium-137 or cobalt-60 in wine are 9 and 8 pCi/L, respectively.

The results for tritium in 1994 wine samples indicate no difference between upwind and downwind locations (Table 5.4.3). Concentrations reported in 1994 are lower than those observed in 1993; however, the difference between years is small. Over the past 5 years, tritium concentrations in wine have ranged as high as three times the MDC of 300 pCi/L. Split samples analyzed by the DOH are generally lower than levels reported by PNL (Dirkes et al. 1994) . Last year, we split samples with DOH and Lawrence Livermore National Laboratory (LLNL). Samples were analyzed by high-resolution mass spectroscopy of helium (He-MS). Helium is the decay product of tritium, and the amount can be quantified, after an extended incubation period, to determine tritium concentrations. The tritium concentrations determined by He-MS are significantly lower than results obtained by the distillation method used by PNL and DOH. (Figure 5.4.4). Tritium analyses performed on water distilled from wine slightly overestimates the true concentration of tritium in wine, assuming that most wines are about 12% alcohol by volume. Very little tritium is believed to be incorporated into the ethanol fraction of wine (NCRP 1979). The distillation method has been used because of lower cost, shorter turnaround time, and the detection limit of 300 pCi/L, which is considerably higher than the He-MS method but sufficiently low enough to ensure public safety. The concentrations of tritium are well below levels considered hazardous for the consumption of liquids. While there is no tritium standard for wine, the standard for drinking water is 20,000 pCi/L.

Table 5.4.3 Tritium Concentrations in Wine (pCi/L of distilled liquid), 1994 Compared to Values from the Previous 5 Years

Type of Wine	Location	1994 Maximum[a]	1994 Mean[b]	1994 No. Less Than Detection[c]
White wine	Columbia Basin	410 ± 200	330 ± 110	1 of 3
	Yakima Valley	490 ± 210	280 ± 230	1 of 3
Red wine	Columbia Basin	430 ± 200	330 ± 100	0 of 3
	Yakima Valley	560 ± 210	470 ± 150	0 of 3

		1989-1993 Maximum[a]	1989-1993 Mean[b]	1989-1993 No. Less Than Detection[c]
White wine	Columbia Basin	930 ± 300	500 ± 130	4 of 15
	Yakima Valley	940 ± 260	450 ± 110	5 of 15
Red wine	Columbia Basin	790 ± 230	420 ± 100	6 of 15
	Yakima Valley	650 ± 240	390 ± 130	4 of 15

(a) Maximum ±2 total propagated analytical uncertainty.
(b) Mean ±2 standard error of the calculated mean.
(c) Number of samples with values less than the ±2 total propagated analytical uncertainty out of number of samples analyzed.

Wheat and Alfalfa

Sample Collection and Analysis

Samples of ripened wheat and mature alfalfa were collected from the areas shown in Figure 5.4.1. Three replicate samples of alfalfa were collected at each location and analyzed for gamma emitters and strontium-90. Wheat from the Sagemoor area was analyzed for gamma emitters, plutonium-239,240, and strontium-90.

Results

No manmade radionuclides were detected in any of the wheat samples collected in 1994. All results for wheat analyses are listed by Bisping (1995).

Alfalfa irrigated with Columbia River water withdrawn downstream from Hanford (Riverview and Horn Rapids) continued to show slightly higher concentrations of strontium-90 relative to other locations (Figure 5.4.5, Table 5.4.4). Samples from Sagemoor and East Wahluke (locations that use Columbia Basin Irrigation Project water), and

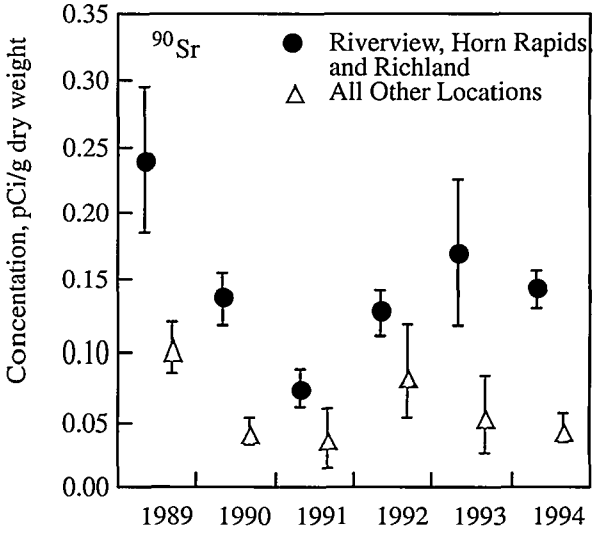

Figure 5.4.5 Mean (±2 standard error of the mean) Strontium-90 Concentrations in Alfalfa Routinely Collected at Riverview, Horn Rapids, Richland and All Other Sampling Locations, 1989 Through 1994

Table 5.4.4 Strontium-90 in Alfalfa Samples (pCi/g dry weight), 1994

Location	Concentration[a]	No. of Samples	Irrigation Water Source
Horn Rapids	0.149 ± 0.009	3	Columbia River
Riverview	0.138 ± 0.030	3	Columbia River
East Wahluke	0.042 ± 0.007	3	Roosevelt Lake[b]
Sagemoor	0.034 ± 0.009	3	Roosevelt Lake
Sunnyside	0.036 ± 0.005	3	Yakima River
Benton City	0.077 ± 0.004	3	Yakima River

(a) Concentrations are means ±2 standard error of the mean.
(b) Columbia Basin Irrigation Project water.

Sunnyside and Benton City (locations that use water from the Yakima River) had strontium-90 concentrations that were lower than those at Riverview and Horn Rapids in 1994. Analysis of Columbia River water at Priest Rapids Dam and the Richland Pumphouse, however, indicated that strontium-90 concentrations in water from both locations were similar. Differences in strontium-90 concentrations in alfalfa, based on sources of irrigation water, appear significant. However, the actual concentrations at all locations are low and difficult to separate from the influence of fallout (Jaquish 1993).

Cesium-137 was the only manmade gamma emitter detected (in four of the 18 samples; two at Sagemoor, one each at Sunnyside and Horn Rapids) in alfalfa at the detection limit (0.02 ± 0.01 pCi/g).